PB90-910207

SELECTED WATER RESOURCES ABSTRACTS

VOLUME 23, NUMBER 7
JULY 1990

W90-05621 -- W90-06554
CODEN: SWRABW

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SELECTED
WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
U.S. Department of the Interior

VOLUME 23, NUMBER 7
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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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For primary bibliographic entry see Field 2E.
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Kobe Univ. (Japan). Dept. of Agricultural Engineering.
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For primary bibliographic entry see Field 4C.
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For primary bibliographic entry see Field 2E.
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Utsunomiya Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05643

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Kanazawa Inst. of Tech. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
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Niigata Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
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Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 2E.
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Rettew Associates, Inc., Lancaster, PA.
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Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05651

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Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05653

SURFACE RUNOFF FROM TURFED AREA IN THE TROPICS.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 2E.
W90-05654

APPLICABILITY OF MANNING'S N VALUES FOR SHALLOW OVERLAND FLOW.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
For primary bibliographic entry see Field 2E.
W90-05655

RESISTANCE TO RAINFALL-RUNOFF ON A TEXTURED SURFACE.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05657

OPTIMUM MANNING ROUGHNESS COEFFICIENTS FOR USE IN A FINITE ELEMENT OVERLAND FLOW MODEL.
Virginia Dept. of Conservation and Historic Resources, Richmond.
For primary bibliographic entry see Field 8B.
W90-05698

RUNOFF CURVE NUMBERS. THE NEXT STEP.
Soil Conservation Service, Washington, DC. Engineering Div.
N. Miller, and P. Cronshey.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 910-916, 3 fig, 9 ref.

Descriptors: *Rainfall-runoff relationships, *Streamflow forecasting, *Runoff, Runoff curve number, Infiltration, Soil properties, Antecedent moisture, Mathematical analysis.

In a review of the Soil Conservation Service runoff curve numbers, two facts have become evident: (1) The concept of average antecedent moisture condition is for one specific location. (2) The median condition, as represented by the runoff curve number varies by location, which seems to indicate that regional runoff curve numbers may be appropriate for design conditions. As an alternative, infiltration-curve-based procedures can be used where continuous simulation models are used, or where a more-accurate physically-based procedure is needed. Green and Ampt infiltration-equation parameters have been derived for 10 soil-

texture classes and have indicated that the results can be used in sensitivity studies of the influence of soil variability on watershed hydrologic outputs. The Green and Ampt equation appears to have wide applicability to modeling the infiltration process. (See also W90-05621) (Cassar-PTT)
W90-05711

EVALUATION OF NATURAL RECHARGE TO AQUIFERS IN THE SUDAN-SAHEL CLIMATE USING GLOBAL HYDROLOGICAL MODELLING: APPLICATION TO TEN SITES IN BURKINA FASO (EVALUATION DE LA RECHARGE NATURELLE DES AQUIFERES IN CLIMAT SOUDANO-SAHELIEN PAR MODELISATION HYDROLOGIQUE GLOBAL: APPLICATION A DIX SITES AU BURKINA FASO).
Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept.
For primary bibliographic entry see Field 2F.
W90-05837

NEW PRACTICAL AID TO REGIONAL HYDROGEOLOGIC PLANNING: THE RUNOFF COEFFICIENT MAP.
Siena Univ. (Italy). Dipt. di Scienze delle Terra.
For primary bibliographic entry see Field 2E.
W90-05864

TIBETAN PLATEAU AS THE WATER RESOURCE OF ASIA (IN JAPANESE).
C. Nakajima.
Chigaku Zasshi (Journal of Geography) CGZAAL, Vol. 98, No. 5, p 57-69, 1989. 9 fig.

Descriptors: *Asia, *Himalayan Mountains, *Snow, *Tibet, *Water resources, Glaciers, Monsoons, Mountains, Orographic precipitation, Rainfall.

Approximately two million people depend upon the rain and snow that falls on the Tibetan Plateau for their water supply. Due to the orographic effect associated with the mountains, the monsoon season provides continuous and heavy rainfall on the southern side of the plateau. The upper elevations of the Himalayas receive a large amount of snowfall due to the monsoon. The glaciers and snowfields of the Himalayas are thus developed in the summer. However, summer is also the season when melting snow and ice supply water to the rivers. The northwestern section of the plateau does not receive much precipitation in the summer but does receive much snowfall in winter. As a result, water is stored during the winter for release during the summer. (Tappert-PTT)
W90-05889

CONTINENTAL SCALE MODELS OF WATER BALANCE AND FLUVIAL TRANSPORT: AN APPLICATION TO SOUTH AMERICA.
New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans and Space.
C. J. Voeroesmarty, V. Moore, A. L. Grace, M. P. Gildea, and J. M. Melillo.
Global Biogeochemical Cycles GBCYEP, Vol. 3, No. 3, p 241-265, September 1989. 15 fig, 5 tab, 78 ref. NASA Grant NAGW-714.

Descriptors: *Amazon River, *Biogeochemistry, *Flow models, *Geochemistry, *Hydrologic budget, *Model studies, *South America, Climates, Evapotranspiration, Flow discharge, Land use, Nutrients, Runoff, Sediment transport, Soil water, Topography, Vegetation effects.

A coupled water balance and water transport model (WBM/WTM) was constructed as part of a larger study of global biogeochemistry. The WBM/WTM provides critical hydrologic information to models of terrestrial primary production, organic matter decay, riverine nutrient flux and trace gas exchanges with the troposphere. Specifically, it creates high-resolution data sets for monthly soil moisture, evapotranspiration, runoff, river discharge and floodplain inundation. As a first step toward eventual global coverage, the WBM/WTM was applied to South America, represented by more than 5700 1/2 degree (latitude/longitude) grid cells. The WBM transforms spatially complex data on long-term climate, vegetation soils and topography into predictions of soil moisture (SM), evapotranspiration (ET) and runoff (RO). For South America, field capacity in soils ranged from 27 to 582 mm of water, and computed values for mean annual SM, ET and RO were 284 mm, 1059 mm/yr and 619 mm/yr, respectively. There were large differences regionally and over the year. The transport model uses WBM-derived runoff, information on fluvial topology, linear transfer through river channels and a simple representation of floodplain inundation to generate monthly discharge estimates for any cell within a simulated catchment. The WTM successfully determined the timing and magnitude of discharge at selected locations within the Amazon/Tocantins basin. It also demonstrated the importance of floodplain inundation in defining flow regime on the mainstem Amazon. Estimated mean annual discharge was 207,000 cu m/sec for the Amazon River and 17,000 cu m/sec for the Tocantins. In these basins, 45% of the incident precipitation emerges as river flow; 55% is lost to ET. The present model will be expanded to include the dynamics of carbon, major nutrients and sediments. It will serve as a semimechanistic tool to quantify the transport of materials from the landscape to the world's oceans. (Author's abstract)
W90-05951

STUDY OF RAINFALL INTERCEPTION USING A LAND SURFACE PARAMETERIZATION FOR MESOSCALE METEOROGICAL MODELS.
Centre National de Recherches Meteorologiques, Toulouse (France).
For primary bibliographic entry see Field 2B.
W90-06027

WATER ENCYCLOPEDIA.
F. van der Leeden, F. L. Troise, and D. K. Todd.
Lewis Publishers, Inc., Chelsea, Michigan. 1990. 808 p.

Descriptors: *Climates, *Groundwater, *Hydrologic data collections, *Hydrology, *Surface water, *Water quality, *Water use, Environmental policy, Legislation, Water resources management.

This second edition of 'The Water Encyclopedia' is a completely revised and expanded version of the original edition published in 1970. As in the first edition, the subject matter has been broadly interpreted to include climates, hydrology, surface and groundwater, water use, water quality, water management, water resources agencies, and legislation. The book ends with a chapter on constants and conversion factors. An entire new chapter, Environmental Problems, has been added, reflecting the greater awareness and concern by the people in this country and elsewhere about contamination of soil and water and environmental quality trends. Among the extensive body of material included in this chapter is information on pollution sources and pathways; contamination of surface water and groundwater; use of pesticides and fertilizers; domestic, municipal and industrial waste disposal; water treatment and reuse; hazardous waste sites; offshore disposal; air pollution; acid rain; and the projected rise of sea levels due to the greenhouse effect. The environmental section concludes with a greatly expanded section on waterborne diseases and toxic effects of chemicals in drinking water. The information is presented in tabular form, except in a few places where text is provided to explain a significant process or activities of a particular organization. Time-dependent data are identified so that the reader can judge the relation of information to the current situation or to his or her particular purpose. (Lantz-PTT)
W90-06196

2B. Precipitation

SENSITIVITY OF STORM RUNOFF HYDROGRAPHS TO HYTEOGRAPH SHAPE.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05622

FUZZY-GROUPING METHOD OF DESIGN STORM-PATTERN ANALYSIS.
Hydrological General Station of Guangdong Province, Guangzhou (China).
C. Qian Wang, S. G. Liao, and H. R. Jiang.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 10-17, 2 tab, 2 ref.

Descriptors: *Precipitation, *Rainfall-runoff relationships, *Rainfall distribution, *Design storms, Fuzzy-grouping method, Mathematical studies, Floods, Design floods, Hydraulic design.

The fuzzy-grouping method was applied to design storm analysis in Guandong Province, China. This involved classification of storm patterns (selection and standardization of storm pattern index, creation of the fuzzy-similar relation among storm patterns, creation of the fuzzy-equivalent relationship, classification of the storm pattern by the matrix of fuzzy-equivalent relationship), derivation of the grouping center (selection of a representative sample), and derivation of the design storm pattern from the prototype. The method was used to derive design storm patterns, and the results were compared with previous analyses. Testing included temporal distribution, spatial variation, and derivation of design flood peak. Precision was better using the fuzzy-grouping method. It considered the similarities and diversities of storms and allowed a rational classification, substituting computer calculations for subjective judgment and hand calculation. (See also W90-05621) (Cassar-PTT)
W90-05623

DISAGGREGATION OF DAILY RAINFALL.
Agricultural Research Service, Tucson, AZ.
D. A. Woolhiser, T. W. Econopouly, and D. R. Davis.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 18-26,1 fig, 3 tab, 12 ref.

Descriptors: *Precipitation, *Rainfall-runoff relationships, *Hydrologic models, *Disaggregation, *Runoff, Rainfall intensity, Infiltration, Model studies, Mathematical studies, Simulation analysis, Catchment areas.

A two-stage approach to disaggregating daily rainfall included: (1) the disaggregation of the daily rainfall process into the intermittent shower process and (2) disaggregation of significant showers into 20 increments using a dimensionless technique. Disaggregation model parameters estimated from data at one station in a climatologically homogeneous region (Midwest U.S., region 3d) were used to disaggregate daily rainfall at another station within the region. Derived distributions of models with an interactive infiltration component appeared relatively insensitive to shower disaggregation model parameters. Therefore, rather simple rainfall intensity patterns were adequate for some cases. (See also W90-05621) (Cassar-PTT)
W90-05624

ONE-DIMENSIONAL MODELING OF MOVING RAINSTORMS.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
J. R. Richardson, and P. Y. Julien.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 27-35, 6 fig, 6 ref.

Descriptors: *Precipitation, *Rainfall-runoff relationships, *Runoff, *Channel flow, *Storms,

*Model studies, *Finite element method, Mathematical studies, Flow, Overland flow, Hydrologic models, Spatial variation, Hydrographs, Flood peak, Flood waves.

A one-dimensional finite element model was developed to simulate surface runoff from rainfall excess. This model was well suited to simulation of overland and channel flows using spatially and temporally varied precipitation fields. Simulations of block moving storms over simple plane and open book geometries were conducted with the model and tested against laboratory results. The results of these simulations compared very well with the laboratory data. Peak discharges for equivalent block moving storms were computed using the numerical model on a single overland flow plane. From this study, it was shown that peak discharges for moving storms could not exceed the peak discharge of stationary storms which reached equilibrium. However, when durations were less than the time to equilibrium, the maximum peak discharge occurred when storms moved down a plane at a speed of approximately half the equilibrium flood wave propagation speed. (See also W90-05621) (Author's abstract)
W90-05625

ARTIFICIAL RAINFALL FOR PAVEMENT RUNOFF STUDIES.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05656

OBJECTIVE NEPHOLOGY.
ST Systems Corp., Lexington, MA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A200 500. Price codes: A06 in paper copy, A01 in microfiche. Report No. AFGL-TR-88-0109, April 15, 1988. 143p, 23 fig, 10 tab, 33 ref. Edited by Alan M. Gerlach.

Descriptors: *Cloud physics, *Weather forecasting, *Meteorology, *Data acquisition, *Clouds, *Remote sensing, *Precipitation, *Climatology, *Model studies, Satellite technology.

Objective nephology is discussed in a final report on five discrete technical areas. The subjects are: (1) Improved Regional Cloud Forecast Model; (2) Global Cloud Characterization from Digital Satellite Data; (3) Cloud/Precipitation Systems; Morphology and motions; (4) Automated Global Cloud Climatology; and (5) Atmospheric Transport and Diffusion. (See W90-05713 thru W90-05717)
W90-05712

APPLICATION AND EXPANSION OF THE RELOCATABLE LIMITED-AREA MODEL (RLAM).
ST Systems Corp., Lexington, MA.
I. M. Halberstam.
IN: Objective Nephology. Report No. AFGL-TR-88-0109, April 15, 1988. p 1-48, 14 fig, 17 ref.

Descriptors: *Clouds, *Weather forecasting, *Storms, *Meteorology, *Model studies, Relocatable Limited-Area Model, Mathematical studies, Cloud physics.

The Relocatable Limited-Area Model (RLAM) has undergone some modifications and has been employed in studies to determine its ability to forecast a storm system off the East Coast of the US. Input and output from RLAM and the Regional Window Model (RWM) have been made compatible so that similar synoptic situations can be tested with both models. Because both share the same physics, differences in the forecasts stem only from numerical considerations, including smoothing and damping terms. Upon receiving an initial data file the forecast model will produce a forecast of any desired length. The file can contain either an initial data set or a previous forecast with the expectation that the model will extend the forecast. The model solves a set of equations where certain terms may even be omitted according to a selection of parameters. In solving the equations the model offers the possibility of choosing among a second-order, fourth-order, or fourth-order compact scheme. Time differencing options allow for leap-frog, Brown-Campana, or semi-implicit schemes. All these options work in concert with staggered grids, as well as with the selected boundary conditions. On 18-19 February 1979 an intense cyclone developed off the eastern shore of the US and brought heavy snow and high winds to the mid-Atlantic coastal states and the District of Columbia. This storm, known as the President's Day storm, has been intensely studied by meteorologists. The storm was particularly difficult to forecast, mainly because it was a small scale disturbance that developed rapidly and deepened precipitously, catching man and model offguard. In an attempt to display the flexibility of RLAM and to pinpoint some of the elements that may have been crucial in forecasting the storm, a series of RLAM forecasts was generated. These experiments indicate that proper numerical schemes are a necessary, but not sufficient, condition for accurate forecast of mesoscale cyclones. From the performance of RLAM, its value as a research tool has been demonstrated. It was possible to isolate various factors, such as smoothing frequency, resolution, or horizontal differencing, simply by setting some parameters and re-running the model. (See also W90-05712) (Lantz-PTT)
W90-05713

GROUND TRUTH FOR OBJECTIVE EVALUATION OF AUTOMATED NEPHANALYSIS.
ST Systems Corp., Lexington, MA.
G. B. Gustafson.
IN: Objective Nephology. Report No. AFGL-TR-88-0109, April 15, 1988. p 49-71, 2 ref, append.

Descriptors: *Meteorology, *Cloud physics, *Data acquisition, *Remote sensing, *Clouds, *Satellite technology, Data interpretation.

An interactive technique has been developed to perform manual cloud analysis from satellite imagery. Trained analysts use standard image processing techniques to improve their ability to interpret and detect cloud features in the imagery. Collocated images from different satellite sensors are used to generate the analysis. Multiple images can be displayed and enhanced simultaneously on an image processing workstation. The analyst can selectively display and enhance the different images to aid in the subjective determination of where the cloud boundaries lie. Identified cloud features are transferred to a 'cloud truth' database through a threshold blanking technique. The available image processing functions aid the analyst in overcoming four problem areas identified with manual interpretation of satellite imagery. The advantages of the system include: (1) area estimates of cloud cover are made directly by the computer through threshold blanking of clear areas; (2) the inability of most observers to discern a large number of grayshades is reduced through various contrast enhancement utilities; (3) interpretation of multispectral data is aided by 24-bit false color displays; and (4) small scale features are enhanced by edge detection convolution algorithms that enhance high frequency features in the data. (See also W90-05712) (Lantz-PTT)
W90-05714

THREE-DIMENSIONAL CLOUD AND PRECIPITATION MAPPING.
ST Systems Corp., Lexington, MA.
F. I. Harris.
IN: Objective Nephology. Report No. AFGL-TR-88-0109, April 15, 1988. p 101-118, 3 fig, 3 tab, 2 ref.

Descriptors: *Meteorology, *Clouds, *Precipitation, *Mapping, *Data interpretation, Satellite technology, Computer programs, Computers, Forecasting.

The Ground-Based Remote Sensing Branch of the Air Force Geophysics Laboratory (AFGL)(AFGL/LYR) is developing a hardware/software system to provide 0-30 minute forecast locations of cloud/precipitation. These forecasts are intended to assist in assessing the quality of those satellite-to-ground communication links that are adversely affected by the presence of hydrometeors in the atmosphere. The system that has been developed, the Remote Atmospheric Probing Information Display (RAPID) System, has several components: Hardware Development and Acquisition, Data and Memory Management, Support Software, Analysis, and Prediction. The software package emphasizes user interaction as opposed to speed. However, the modular nature of the software and the expansive use of the memory within the software and the expansive use of the memory within the ADAGE image processor should allow an easy transition to a real-time analysis system. (See also W90-05712) (Lantz-PTT)
W90-05716

AUTOMATED GLOBAL CLOUD CLIMATOLOGY.
ST Systems Corp., Lexington, MA.
A. R. Boehm.
IN: Objective Nephology. Report No. AFGL-TR-88-0109, April 15, 1988. p 119-138, 3 fig, 2 tab, 8 ref.

Descriptors: *Climatology, *Meteorology, *Cloud cover, *Data interpretation, *Computer programs, Clouds, Statistical analysis, Fourier analysis, Distribution patterns.

An effective methodology for analyzing sky cover has been developed. The analysis makes use of the Burger (database) distribution with its two parameters, mean and scale distance, to specify any value of the distribution. The mean and the scale distance are analyzed in time of day and time of year by a two-dimensional Fourier analysis. They are analyzed in space by a Fourier/Legendre analysis. The resultant scheme can synthesize a complete sky cover distribution for any location between 60 South and 60 North. (See also W90-05712) (Lantz-PTT)
W90-05717

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR CHERRY POINT, NC.
Naval Oceanography Command Detachment, Asheville, NC.
For primary bibliographic entry see Field 7C.
W90-05721

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR SOUTH WEYMOUTH, MA.
Naval Oceanography Command Detachment, Asheville, NC.
For primary bibliographic entry see Field 7C.
W90-05722

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR LAKEHURST, NJ.
Naval Oceanography Command Detachment, Asheville, NC.
For primary bibliographic entry see Field 7C.
W90-05723

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR BERMUDA NAS.
Naval Oceanography Command Detachment, Asheville, NC.
For primary bibliographic entry see Field 7C.
W90-05724

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR ALAMEDA, CA.
Naval Oceanography Command Detachment, Asheville, NC.
For primary bibliographic entry see Field 7C.
W90-05725

Group 2B—Precipitation

RECONSTRUCTED DROUGHT HISTORY, NORTH-CENTRAL GREAT BASIN: 1601-1982.
Geological Survey, Carson City, NV. Water Resources Div.
W. D. Nichols.
IN: Aspects of Climate Variability in the Pacific and the Western Americas. American Geophysical Union, Washington, D.C, Geophysical Monograph 55, December 1989. p 61-67, 5 fig, 5 tab, 14 ref.

Descriptors: *Drought, *History, *Nevada, *Paleohydrology, *Dendrochronology, *Tree rings, Palmer Drought Severity Index, Water deficit, Precipitation, Regression analysis, Statistical studies.

A regional tree-ring chronology for northeastern Nevada shows strong correlation to the July Palmer Drought Severity Index (PDSI) for the northeastern Nevada Climatic Division. Multiple linear regression analysis using this chronology has been used to reconstruct the July PDSI from 1601-1982. The regression equation (period 1932-1981, 50 years) explains 74% of the variance of the index for the calibration period. The reconstructed drought record shows that there have been 100 drought years in the 382 years since 1601. Sixty-four percent of these years occurred as 1-or-2-year droughts. The reconstructed index suggests that incipient to mild drought conditions were experienced in 41% of these years, whereas severe to extreme drought conditions were experienced in 37% of the years. One-year droughts account for 54% of the drought events since 1601. Two-year droughts have occurred half as often as 1-year droughts, accounting for 27% of events. Three year droughts, account for 15% of the drought events. Single-year droughts tended to be incipient to moderate, but multiple-year droughts were more commonly moderate to extreme. Droughts of 4-years and 5-years duration are uncommon, each having occurred only once in the last 382 years. The 20th century has had the most severe single drought year since 1601, but the 18th and 19th centuries have had more years of drought, more multi-year droughts, and more droughts of severe to extreme intensity. Both the 18th and 19th centuries had 31 years of (reconstructed) drought, with 10 occurrences of multi-year drought in the 18th century and 9 in the 19th century. The 18th century had 14 occurrences of severe to extreme drought, while there were 13 occurrences in the 19th century. The longest drought-free span in the 18th century was 7 years, and in the 19th century was 8 years. (Lantz-PTT)
W90-05747

MESOSCALE SEVERE WEATHER DEVELOPMENT UNDER OROGRAPHIC INFLUENCES.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
E. R. Reiter, J. D. Sheaffer, and M. A. Klitch.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A205-082. Price codes: A03 in paper copy, A01 in microfiche. Report No. AFOSR-TR-89-0095, January 1989. 24p, 6 fig, 2 tab, 19 ref. Air Force Grant F49620-86-C-0080.

Descriptors: *Orographic precipitation, *Weather patterns, *Energy transfer, Thermal energy, Gobi Desert, Tibet, Heat transfer, Model studies, Flash floods, Cyclones, Kansas, Rocky Mountains.

Measurements of surface energy budgets have been carried out at several sites in the Colorado Rocky Mountains, in the Kansas Prairie, in the Gobi Desert and in Tibet. The fluxes of sensible heat, H sub s, from the surface could be estimated as functions of the difference between air temperature and infrared 'skin surface' temperature, as seen by remote sensing instruments. Computations of H sub s involve a neutral stability coefficient for turbulent transfer (drag coefficient), C sub T, ranging between 0.0021 (Gobi Desert) and 0.0070 (alpine tundra), and a scaling factor for stability. Latent heat fluxes were estimated either as residual of total energy fluxes or through a Bowen ratio approach. These flux estimates worked well in a mesoscale, nested-grid model over the Rocky Mountains. The model was able to predict with considerable skill flash-flood events such as the Big Thompson flood of 1976 and the Cheyenne flood of 1985. By implanting 'features' such as a vorticity maximum associated with a low-level jet stream, the model without the nested grid was able to predict severe cyclogenesis ('bomb' formation) over the eastern United States. Both model versions run on a desktop workstation. (Lantz-PTT)
W90-05769

STATION CLIMATIC SUMMARIES: EUROPE.
Air Force Environmental Technical Applications Center, Scott AFB, IL.
For primary bibliographic entry see Field 7C.
W90-05770

CONTRIBUTION OF ATMOSPHERIC NITRATE DEPOSITION TO NITRATE LOADING IN THE CHESAPEAKE BAY.
Versar, Inc., Columbia, MD.
For primary bibliographic entry see Field 5B.
W90-05823

ROCKY MOUNTAIN ACID DEPOSITION MODEL ASSESSMENT: ACID RAIN MOUNTAIN MESOSCALE MODEL (ARM3).
Systems Applications, Inc., San Rafael, CA.
For primary bibliographic entry see Field 5B.
W90-05831

AMPEROMETRIC FLOW INJECTION TECHNIQUE FOR DETERMINATION OF HYDROGEN PEROXIDE AND SULFUR(IV) IN ATMOSPHERIC LIQUID WATER.
Sao Paulo Univ. (Brazil). Dept. of Chemistry.
For primary bibliographic entry see Field 7B.
W90-05834

RATES OF ACID DEPOSITION AND THEIR INTERACTION WITH FOREST CANOPY AND SOIL IN TWO BEECH FOREST ECOSYSTEMS ON LIMESTONE AND TRIASSIC SANDSTONE SOILS IN N. GERMANY.
Goettingen Univ. (Germany, F.R.). Abt. Bodenkunde und Waldernahrung.
For primary bibliographic entry see Field 5B.
W90-05871

CHARACTERISTIC TIME TO ACHIEVE INTERFACIAL PHASE EQUILIBRIUM IN CLOUD DROPS.
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5B.
W90-05904

DETERMINATION OF ORGANIC AND INORGANIC ACIDS IN PRECIPITATION SAMPLES.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
For primary bibliographic entry see Field 5A.
W90-05914

OXYGEN ISOTOPIC VARIATION OF FALLING SNOW PARTICLES WITH TIME DURING THE LIFETIME OF A CONVECTIVE CLOUD: OBSERVATION AND MODELLING.
Nagoya Univ. (Japan). Water Research Inst.
For primary bibliographic entry see Field 2K.
W90-05975

METEOROLOGICAL CHARACTERISTICS OF LARGE ACIDIC DEPOSITION EVENTS AT KEJIMKUJIK, NOVA SCOTIA.
Atmospheric Environment Service, Bedford (Nova Scotia).
B. L. Beattie, and D. M. Whelpdale.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 45-59, July/August 1989. 1 fig, 6 tab, 17 ref.

Descriptors: *Acid rain, *Canada, *Deposition, *Hydrogen ion concentration, *Nitrates, *Precipitation, *Sulfates, *Weather patterns, Acidity, Air pollution, Kejimkujik National Park, Nova Scotia, Water pollution, Weather forecasting.

The characteristics of acidic deposition at Kejimkujik National Park, a rural site in south-central Nova Scotia, were determined for the period from May 1979 to December 1983. The acidifying pollutants investigated were H(+), sulfate ion and nitrate ion. 30% of the total annual amount of acidifying pollutants deposited by precipitation at Kejimkujik was deposited by only about 8% of the precipitation events during the year. These occasions of large deposition are referred to as episodes and occurred, on average, about five times per year, usually between March and November. The precipitation events that produced episodes were almost always rain events. The major meteorological feature producing deposition episodes at Kejimkujik is the sequence of a large high pressure area from midcontinent moving south of Nova Scotia, producing a prolonged southwesterly to westerly flow over the site, and then a weak frontal system, usually from south of the Great Lakes region, bringing moderate amounts of precipitation to the site. Since deposition episodes were almost always preceded by the above sequence of events, the ability to predict episodes was investigated. The results indicate that many false alarms could be anticipated because this sequence also occurs for nonepisodes. (Author's abstract)
W90-05980

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THREE ACIDIC, OLIGOTROPHIC LAKES AND THEIR WATERSHEDS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5B.
W90-05981

STUDY OF RAINFALL INTERCEPTION USING A LAND SURFACE PARAMETERIZATION FOR MESOSCALE METEOROGICAL MODELS.
Centre National de Recherches Meteorologiques, Toulouse (France).
J. Mahfouf, and B. Jacquemin.
Journal of Applied Meteorology JAMOAX, Vol. 28, No. 12, p 1282-1302, December 1989. 17 fig, 33 ref, 2 append. Institut National des Sciences de l'Universite Grant PAM883614.

Descriptors: *Interception, *Meteorological data, *Model studies, *Parametric hydrology, *Rainfall-runoff relationships, Canopy, Evaporation rate, Model testing, Plant morphology, Rainfall penetration, Vegetation.

Rainfall interception by vegetation canopies is studied using a parameterization of land surface processes for mesoscale meteorological models. The interception scheme allows for a single vegetation canopy, and manages interception through a prognostic variable representing the amount of liquid water retained by the foliage. A set of 24 hour simulations, fully interactive with the boundary layer, is carried out with a one-dimensional model in order to examine the sensitivity of the interception scheme to vegetation properties. The evaporation from the interception reservoir is strongly enhanced by high values of the roughness length. The leaf area index, acting on the maximum storage capacity, modifies the drying time of the foliage. As a first stage of validation, the interception scheme is compared with other models developed for hydrological purposes. It appears that the scheme us not very different from the single-layer Rutter model, which has been well tested and validated. Only minor differences are noticed between the results of the two models. The scheme is also compared with a multilayer model that provides a more physical description of the rainfall interception. The main departure concerns the drying time of the canopy, which is almost independent of the rainfall rate in the single-layer model. Finally, a validation of the interception scheme is made using micrometeorological data from the Hydrologic and Atmospheric Pilot Experiment-Modelisation du Bilan Hydrique (HAPEX-MOBILHY) experiment. Six simulations lasting 24 hours indicate that the parameterization reproduces well the daily evolution of the compo-

nents of the surface energy balance for various surface conditions and various rainfall distributions. (Author's abstract)
W90-06027

DOMINATING INFLUENCE OF NH3 ON THE OXIDATION OF AQUEOUS SO2: THE COUPLING OF NH3 AND SO2 IN ATMOSPHERIC WATER.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 2K.
W90-06096

IMPACT OF SOIL-DERIVED AEROSOLS ON PRECIPITATION ACIDITY, IN INDIA.
Meteorological Office, Poona (India).
For primary bibliographic entry see Field 2K.
W90-06097

ASSESSING THE POTENTIAL EXTENT OF DAMAGE TO INLAND LAKES IN EASTERN CANADA DUE TO ACIDIC DEPOSITION. I. DEVELOPMENT AND EVALUATION OF A SIMPLE 'SITE' MODEL.
Environmental and Social Systems Analysts Ltd., Vancouver (British Columbia).
For primary bibliographic entry see Field 5C.
W90-06113

ASSESSING THE POTENTIAL EXTENT OF DAMAGE TO INLAND LAKES IN EASTERN CANADA DUE TO ACIDIC DEPOSITION: II. APPLICATION OF THE REGIONAL MODEL.
Environmental and Social Systems Analysts Ltd., Toronto (Ontario).
For primary bibliographic entry see Field 5C.
W90-06114

COMPARATIVE STUDY OF PRECIPITATION CHEMISTRY AT INLAND, COASTAL AND ISLAND SITES IN THE BOTHNIAN BAY AREA.
Stockholm Univ. (Sweden). Meteorologiska Institutionen.
L. Granat.
Available from the National Technical Information Service, Springfield, VA. 22161, as N89-12135. Price codes: A03 in paper copy, A01 in microfiche. Report No. CM-73, May 1988. 19p, 5 fig, 4 tab, 2 ref. National Swedish Environment Protecting Board Contract Nos. 623-2415-87 and 623-3104-85.

Descriptors: *Acid rain, *Chemistry of precipitation, *Gulf of Bothnian, *Path of pollutants, Ammonium, Calcium, Nitrates, Potassium, Precipitation, Rainfall, Sulfates.

Rain chemistry measurements were made in the northern part of the Baltic in the Gulf of Bothnia (Kvarken) on both a small island and on a lighthouse and compared with data from nine coastal and inland sites on both sides of the water. The distance from coast to coast in the area is 120 km. The concentration of SO4(-2), NO3(-), and H(+) at the island site was about equal and NH4(+) about 10% less than the value obtained by linear interpolation between coastal sites. The amount of precipitation was about 30% less on the island--possibly representing conditions over the open water. The deposition was, therefore, estimated to be 30 to 40% lower than the values measured at coastal sites. The concentration of sea salt components was higher at the island site but the level may depend on the sampling site. The concentration of Ca and K was a few micrograms/L higher at the island site. This study together with information from the national Swedish air and precipitation chemistry network suggests that estimates of wet deposition of several components of anthropogenic origin to a large water body should be made from a combination of concentration data obtained from many measurements around the water body with particular reference to coastal sites and estimated amount of precipitation over the water. A direct estimate based on deposition at coastal sites will give too high values. The measurements at the lighthouse were probably affected by the very exposed location and the results were considered to be less reliable than those from the much less exposed site on the island. (Author's abstract)
W90-06171

HMR52 PROBABLE MAXIMUM STORM (EASTERN UNITED STATES): USERS MANUAL.
Hydrologic Engineering Center, Davis, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-564. Price codes: A04 in paper copy, A01 in microfiche. March 1984. 89p, 26 fig, 24 tab, 9 ref, 2 append.

Descriptors: *Computer programs, *Handbooks, *Probable maximum precipitation, *Storms, Precipitation, Spatial distribution, Temporal distribution.

Computer program HMR53 computes basin-average precipitation for Probable Maximum Storms (PMS) in accordance with the criteria specified in Hydrometeorological Report (HMR) No. 52. The HMR describes a procedure for developing a temporal and spatial storm pattern to be associated with the Probable Maximum Precipitation (PMP) estimates provided in HMR No. 51. 'Probable Maximum Precipitation Estimates--United States East of the 105th Meridian.' Data required for application of the HMR52 program are: (1) X, Y coordinates describing the river basin and subbasin watershed boundaries; (2) PMP from HMR No. 51; and (3) storm orientation, size, centering, and timing. The program computes the spatially average PMP for any of the subbasins or combinations. The HMR52 computer program will optimize the storm area size and orientation in order to produce the maximum basin average precipitation. The user must provide the desired centering and time distribution for the storm. The HMR52 program will produce a precipitation data file which can subsequently be input to a rainfall-runoff model, such as HEC1. (Author's abstract)
W90-06193

3CPO--CLOUD CHEMISTRY AND CLOUD PHYSICS ORGANIZATION. JUNE 1988: DATA INDEX.
Brookhaven National Lab., Upton, NY. Atmospheric Sciences Div.
J. Tichler, K. Norden, and D. Sharp.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-007011. Price codes: A04 in paper copy, A01 in microfiche. Report No. BNL-42203, December 1988. 96p, 6 fig, 2 tab. DOE Contract DE-AC02-76CH00016.

Descriptors: *Acid rain, *Air pollution, *Cloud chemistry, *Cloud physics, *Data collections, *Illinois, *Water pollution sources, Convective precipitation, Precipitation, Remote sensing, Storms.

Data that were collected as part of the Cloud Chemistry and Cloud Physics Organization (3CPO) cooperative convective storms program which took place in June 1988 in east central Illinois are tabulated. The objective of 3CPO was to assemble at a common time and location the necessary measurement facilities to provide a previously unattained description of convective storm characteristics in polluted environments. Unfortunately, the spring of 1988 was the warmest and driest spring observed since the dust bowl years. The average June precipitation amount for the study area is 5.0 inches, compared with 0.32 inches received in 1988. The unseasonably dry weather during 3CPO caused the modification of the field strategy, to extend the length of the field observation period and to divert measurement resources to clear air applications. Section 2 of the report describes the measurements made during the project. Some were made continuously throughout the month of June; others were specific to project missions. Section 3 describes the nine 3CPO missions that took place during the project on June 2, 7, 8, 13, 15, 17, 20, 22 and 24, and includes the following information for each mission: weather summary; mission objectives; soundings--CLASS and/or AFGL; data on each flight, such as take off and landing times; for the P-C aircraft, a listing of the times and altitudes at which samples were taken or measurements made (Doppler radar, radar reflectivity), a list of times and altitudes at which hydrocarbon grab samples, if any, were taken; and a listing of batch samples collected that day at Bondville and Monticello, IL.. (Lantz-PTT)
W90-06212

COMPARISON OF SNOW GAUGES USED IN NORDIC COUNTRIES: CONTRIBUTION OF FINLAND TO WMO SOLID PRECIPITATION MEASUREMENT INTERCOMPARISON. PART I: SYSTEM DESCRIPTION.
Finnish Meteorological Inst., Helsinki.
For primary bibliographic entry see Field 7B.
W90-06214

AUTOMATED METHOD FOR REPRESENTING, TRACKING AND FORECASTING RAIN FIELDS OF SEVERE STORMS BY CONVENTIONAL AND DOPPLER WEATHER RADARS.
California Univ., Davis. Dept. of Civil Engineering.
Z. Q. Chen, M. L. Kavvas, and G. T. Orbol.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-138629/AS. Price codes: A05 in paper copy, A01 in microfiche. Completion Report, September 1989. 80p, 29 fig, 15 ref. USGS Contract 14-08-0001-G1291.

Descriptors: *Prediction, *Radar, *Rain distribution, *Statistical methods, *Weather forecasting, *Weather patterns, Model studies, Radar data, Rain intensity, Severe storms, Statistical models.

A new automated method was developed in order to track and predict in short-term (15 min-2 hr lead times) the evolution of rain fields in time and space, as observed by weather radars. First the rain field is decomposed into simple, tractable elements. Then a statistical adaptive forecasting scheme is developed in order to predict the changes in each of these elements in time. The composition of these elements forms the complete rain field with respect to its spatial configuration, location and rain intensity texture at each prediction lead time. The method has been applied to the conventional and doppler digital weather radar data of rain fields. Some application results are given. (USGS)
W90-06238

DISTRIBUTION AND VARIABILITY OF PRECIPITATION CHEMISTRY IN THE CONTERMINOUS UNITED STATES, JANUARY THROUGH DECEMBER 1983.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-06239

2C. Snow, Ice, and Frost

EFFECTS OF AN ICE COVER ON THE COMPOSITE VALUE OF MANNING'S N.
Michigan Technological Univ., Houghton. Dept. of Civil and Environmental Engineering.
H. S. Santeford, and G. R. Alger.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 539-548, 2 tab, 17 ref.

Descriptors: *Ice cover, *Hydraulics, *Streamflow, *Channel flow, *Mannings equation, Roughness coefficient, Hydraulic roughness, Flow velocity, Water depth, Backwater, Reservoirs, Weirs, Hydraulic resistance.

A four-year study of ice cover effects on depth-discharge relationships was conducted in Michigan streams. When the depth-discharge relationships were dependent on resistance (uniform flow or drawdown), the under-ice flow area and mean velocity were the same as existed for the open water condition at the same discharge. The ice cover produced a redistribution of shear forces, but not an increase in overall resistance. For such

reaches, the water level or stage was increased by an amount equal to the submerged thickness of the ice. For sections along a backwater curve located upstream of a weir, water surface elevations were unaffected by the presence or thickness of an ice cover, providing that the remaining space under the ice was greater than the normal depth. (See also W90-05621) (Cassar-PTT)
W90-05680

FORMATION OF POLAR SURFACE WATER, THE ICE EXPORT AND THE EXCHANGES THROUGH THE FRAM STRAIT.
Hamburg Univ. (Germany, F.R.). Inst. fuer Meerskunde.
For primary bibliographic entry see Field 2L.
W90-05880

TIBETAN PLATEAU AS THE WATER RESOURCE OF ASIA (IN JAPANESE).
For primary bibliographic entry see Field 2A.
W90-05889

ATMOSPHERIC AND DEPOSITIONAL ENVIRONMENTS TRACED FROM UNIQUE CHEMICAL COMPOSITIONS OF THE SNOW OVER AN INLAND HIGH PLATEAU, ANTARCTICA.
Kyoto Univ., Beppu (Japan). Geophysical Research Station.
K. Kamiyama, Y. Ageta, and Y. Fujii.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 94, No. 15, p 18,515-18,519, December 1989. 7 fig, 1 tab, 27 ref.

Descriptors: *Acid rain, *Antarctica, *Chemistry of precipitation, *Snow sampling, *Snow surveys, *Tritium, *Water chemistry, Atmospheric chemistry, Chlorides, Conductivity, Geochemistry, Hydrogen, Nitrates, Regional analysis.

Surface snow samples from the inland high plateau, East Queen Maud Land, Antarctica, are characterized by high acidity accompanying the high electrical conductivity, so that the hydrogen ion is the dominant ion, coupling with chloride and nitrate ions. The chemical composition differs sharply from sea salts. These characteristics appear more clearly than previously reported in Antarctic and are most strongly developed in snow samples from the high region. The tritium content increases in the inland high area, especially in the region higher than 3600 m above sea level, which corresponds to the region where the effects of katabatic wind have vanished in the glaciological observations. The highest tritium content occurs in the vertical profile at a snow pit (3761 m above sea level, 77 deg 00 min S, 35 deg 00 min E), which corresponds to the snow deposition in 1966. The concentration is the highest ever reported in Antarctica and is almost as high as the one observed in the precipitation in the inland of North America, which is the highest value ever reported in the world. All the results suggest that most of the ions contained in snow samples from the inland high plateau, especially higher than 3600 m above sea level, are not brought directly through the troposphere from the sea around Antarctica but from the higher atmosphere and that they are under the influence of the physicochemical reactions occurring there. (Author's abstract)
W90-05963

OXYGEN ISOTOPIC VARIATION OF FALLING SNOW PARTICLES WITH TIME DURING THE LIFETIME OF A CONVECTIVE CLOUD: OBSERVATION AND MODELLING.
Nagoya Univ. (Japan). Water Research Inst.
For primary bibliographic entry see Field 2K.
W90-05975

RELATIONSHIP BETWEEN ARCTIC SEA-ICE ANOMALIES AND FLUCTUATIONS IN NORTHERN CANADIAN AIR TEMPERATURE AND RIVER DISCHARGE.
McGill Univ., Montreal (Quebec). Dept. of Meteorology.
D. A. Manak, and L. A. Mysak.
Atmosphere - Ocean ATOCDA, Vol. 27, No. 4, p 682-691, December 1989. 6 fig, 2 tab, 13 ref.

Descriptors: *Air temperature, *Arctic zone, *Canada, *Climatology, *Marine climates, *Sea ice, Climatic data, Correlation analysis, Freezing, Melting, Stream discharge, Water temperature.

Sea-ice acts as a thermal reservoir, delaying the seasonal temperature cycle. Air temperature directly affects surface melting and freezing. A lagged cross-correlation analysis of climatic data from the period 1953-1984 was carried out for three regions of Northern Canada (Beaufort Sea, Hudson Bay, Baffin Bay/Labrador Sea) to determine the relationships between sea-ice anomalies and surface air temperature and river discharge anomalies. Ice lagged temperature by several months in the Beaufort Sea and Hudson Bay regions; the lag was zero in the Baffin Bay/Labrador Sea region. Significant negative correlations at the 95% level were found between sea-ice and temperature anomalies in all sites. A significant correlation at the 95% level was found between sea-ice and river discharge anomalies in only one of two subregions studied, the Beaufort Sea. (Author's abstract)
W90-06012

COMPARISON OF SNOW GAUGES USED IN NORDIC COUNTRIES: CONTRIBUTION OF FINLAND TO WMO SOLID PRECIPITATION MEASUREMENT INTERCOMPARISON. PART I: SYSTEM DESCRIPTION.
Finnish Meteorological Inst., Helsinki.
For primary bibliographic entry see Field 7B.
W90-06214

2D. Evaporation and Transpiration

RELATIONSHIP BETWEEN ARCTIC SEA-ICE ANOMALIES AND FLUCTUATIONS IN NORTHERN CANADIAN AIR TEMPERATURE AND RIVER DISCHARGE.
McGill Univ., Montreal (Quebec). Dept. of Meteorology.
For primary bibliographic entry see Field 2C.
W90-06012

2E. Streamflow and Runoff

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON CHANNEL FLOW AND CATCHMENT RUNOFF: CENTENNIAL OF MANNING'S FORMULA AND KUICHLING'S RATIONAL FORMULA.
22-26 May, 1989, at the University of Virginia. University of Virginia, Charlottesville, VA. 1989. 916p. Edited by Ben Chie Yen.

Descriptors: *Runoff forecasting, *Flood forecasting, *Urban hydrology, *Hydrologic models, *Rainfall-runoff relationships, *Hydraulics, *Channel flow, *Open-channel flow, Mannings equation, Rational formula, Catchment areas, Runoff, Roughness coefficient, Rivers, Kuichlings rational method, Pipe flow, Storms, Floods, Model studies, Mathematical studies, Hydraulic roughness, Hydrographs, Flow, Watersheds, Flow velocity, Velocity distribution, Sediment transport, River beds, Flood plains, Flow resistance, Resistance, Hydraulic friction, Friction, Drainage systems.

A conference was held to reflect on the centennials of two widely used formulas in hydraulics and hydrology: Manning's formula for open channel and pipe flows and Kuichling's rational formula for catchment runoff. Papers presented at the conference concerned theoretical aspects, model development, and practical applications of the formulas. Some of the engineering uses included flood forecasting and control, sediment yield and transport, drainage systems, urban storm water management, highway pavement drainage, sewer systems, flow under ice cover, and vegetation effects on flow. (See W90-05622 thru W90-05711) (Cassar-PTT)
W90-05621

SENSITIVITY OF STORM RUNOFF HYDROGRAPHS TO HYTEOGRAPH SHAPE.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
G. Aron.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 1-9, 7 fig, 4 tab, 6 ref.

Descriptors: *Rainfall-runoff relationships, *Hydrographs, *Storm runoff, *Hyetographs, *Hydrologic models, Sensitivity analysis, Model studies, Pennsylvania, Rainfall intensity, Design storms, Computer models, Precipitation, Runoff, Watersheds, Rainfall distribution, Yarnell curves.

The sensitivity of the shape of a model-generated storm hydrograph to the design storm distribution, and in particular to the peak intensity of the storm, was studied by applying various commonly used standard storm distributions to a hypothetical watershed located in Southeastern Pennsylvania. Several intensity-duration-frequency distributions, previously available only in graphical form, were expressed in the form of equations to simplify their use in computer programs. It was found that among the chosen distributions, the largest runoff peaks were obtained by applying the SCS type II storm, followed by the SCS Type III and the PDT-IDF distributions. Hydrographs generated with the use of the Yarnell curves were almost identical to those generated by a PDT-IDF storm, and the SCS Type I distribution resulted in a much lower runoff peak. (See also W90-05621) (Author's abstract)
W90-05622

FUZZY-GROUPING METHOD OF DESIGN STORM-PATTERN ANALYSIS.
Hydrological General Station of Guangdong Province, Guangzhou (China).
For primary bibliographic entry see Field 2B.
W90-05623

EFFECTS OF HYETOGRAPH SHAPE ON DETENTION POND SIZING.
Dominion Engineering Resources, Newport News, VA.
J. N. Paine.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 36-44, 3 fig, 2 tab, 7 ref.

Descriptors: *Hydrograph analysis, *Model studies, *Storm runoff, *Urban runoff, *Rainfall-runoff relationships, *Hydraulic structures, *Hyetographs, *Detention reservoirs, Runoff, Storm water, Jones Run Watershed, Virginia, DOWAP model, Computer models, Mathematical models, Hydrographs, Rainfall intensity, Drainage, Design criteria, Flood protection, Water storage, Catchment basins, Routing, Flood routing.

Extended hydrologic simulation was used to size a regional detention facility serving the 937-acre Jones Run, Virginia, watershed. The method used a three-part package (the Dominion Watershed Analysis Package, DOWAP) to continuously compute runoff hydrographs from 21 years of locally recorded rainfall data. The runoff hydrographs were then hydraulically routed through the drainage system on a continuous basis. A total of 1288 storm events comprised the simulation. A statistical program was then used to project 21-year results to 10, 25, and 100 year levels. The process allowed continuous modeling of soil moisture redistribution and infiltration. In addition, hydraulic storage in the pond and drainage network was computed continuously. The computed excavation required was 15,000 cu yd, compared with 260,000 cu yd obtained using the Soil Conservation Service Type II hyetograph. Single-event hyetographs were also run through the same model, and results varied widely. Several conclusions were reached: (1) higher rainfall volumes consistently produced higher pond elevations for the hyetograph shapes

studied; (2) where hyetographs had varying times to peak intensity, pond elevation (flood storage required) increased as time to peak intensity increased; (3) there was no way to predict which hyetograph and design conditions were most appropriate for the site without doing the continuous simulation and comparing the results; (4) flood storage discrepancies resulting from different hyetograph shapes decreased as rainfall depth increased, while flood elevation increased; and (5) the highest hyetograph intensities did not produce the highest pond elevations. (See also W90-05621) (Cassar-PTT)
W90-05626

PEELING TWO MISLEADING CONCEPTS OFF THE RATIONAL METHOD.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
A. Ben-Zvi.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 45-50, 26 ref.

Descriptors: *Urban hydrology, *Urban runoff, *Runoff forecasting, *Watersheds, *Rainfall-runoff relationships, *Rational formula, Runoff, Kuichling rational method, Runoff coefficient, Hydrologic models, Mathematical studies, Hydrographs, Flood peak, Watersheds.

Modifications of the 100-year-old Rational Method of Kuichling were proposed. These include elimination of two misleading concepts and the addition of two new procedures. The eliminated concepts were (1) that a watershed has a unique time of concentration which is equal to the time of flow along the watershed; and (2) that a rainfall event of a given occurrence probability results in a runoff event of the same probability. Added procedures were a formulation which links the peak discharge to the intensity and duration of the causative rainfall, with no explicit reference to a time of concentration and generation of a complete series of peak discharges. The proposed rainfall-runoff relationship was calibrated through an envelop line describing the case of minimal abstraction. The following procedure was suggested. Separate the rainfall data into effective and abstractive components. Using an equation, calculate a series of peak runoff discharges. Use this series, together with the recorded series of peak discharges, for statistical analysis. (See also W90-05621) (Cassar-PTT)
W90-05627

DEVELOPMENT OF THE RATIONAL METHOD FOR FLOOD DESIGN FOR SMALL RURAL BASINS IN AUSTRALIA.
New South Wales Univ., Kensington (Australia).
D. H. Pilgrim, G. E. McDermott, and G. E. Mittelstadt.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 51-60, 4 fig, 24 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Flood forecasting, *Rational formula, *Australia, *Design floods, *Rural watersheds, Watersheds, Kuichling rational method, Runoff coefficient, Probabilistic process, Mathematical studies, Hydrographs, Hydrologic models, Flood frequency, Storms, Flood discharge.

The probabilistic interpretation of the Rational Method has been used for flood design on small rural basins in Australia during the past 20 years. The practice of basing designs on observed flood data, rather than judgment and experience as in the conventional Rational Method, produced a much sounder basis for flood design. The alternative interpretation recognized that the objective in design practice is not to estimate the flood runoff from an individual storm, but to estimate the flood peak of a selected average recurrence interval from a design rainfall of some critical duration and the same average recurrence interval. The design procedure for eastern New South Wales is given as an example. Time of concentration was found to be related to area of the basin. Probabilistic runoff coefficients were derived from frequency analyses of observed floods on 308 basins. Runoff coefficients (10-yr) showed no relationship to basin size up to 250 sq km. The method was also applicable with fair to good accuracy up to an average recurrence interval of 50 yr; flood estimates for average recurrence intervals of 100 yr were only fair but nevertheless usable. Although distance from the coast was a factor in values of runoff coefficient, soil type, relief, and vegetation were not influential. (See also W90-05621) (Cassar-PTT)
W90-05628

RE-EVALUATION OF RATIONAL METHOD USING KINEMATIC WAVE APPROACH.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
C.-N Chen, and T. S. W. Wong.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 61-70, 8 fig, 1 tab, 18 ref.

Descriptors: *Kinematic wave theory, *Runoff forecasting, *Rainfall-runoff relationships, *Rational formula, *Overland flow, Runoff, Watersheds, Runoff coefficient, Kuichling rational method, Singapore, Kinematic waves, Rainfall intensity, Flood peak, Infiltration.

The kinematic wave approach was used to evaluate the two fundamental parameters in the rational method: the runoff coefficient and the time of concentration. Overland flow for Singapore rainfall of 5-year recurrence interval provided a basis for the comparison of the methods. The rational method gave higher peak discharges than the kinematic wave approach even when the effect of rainfall intensity was included in the time of concentration. The difference in the estimates was especially great when the relative effect of infiltration on rainfall intensity was large. (See also W90-05621) (Cassar-PTT)
W90-05629

IS THE RATIONAL METHOD RELIABLE FOR AGRICULTURAL WATERSHEDS.
McGill Univ., Montreal (Quebec). Dept. of Agricultural Engineering.
C. A. Madramootoo, P. Enright, and V. T. V. Nguyen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 71-77, 1 fig, 3 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Storm runoff, *Agricultural watersheds, *Rational formula, Watersheds, Kuichling rational method, Mathematical studies, Runoff coefficient, Canada, Flood peak, Seasonal variation, Drainage, Storms, Infiltration, Rainfall intensity.

Rainfall and runoff measurements from a small, flat rural watershed in western Quebec were analyzed using the rational method. Thirteen rainfall events causing runoff were recorded during the 1985 to 1988 growing seasons. The runoff coefficient was not a constant watershed parameter, varying seasonally. Higher values were observed in April (0.62) and in November (0.33), reflecting greater runoff potential. During July and August, runoff coefficients were 0.10 and 0.08, respectively. The single June rainfall event produced a runoff coefficient of 0.05, considered an aberration, with 0.10 to 0.12 a more realistic range for June. Although the runoff coefficient for October was 0.12, it was believed that values of 0.17 to 0.33 would be more realistic. In spring and autumn, the rainfall events were long and of low intensity. The rational method tended to overpredict peak flows. (See also W90-05621) (Cassar-PTT)
W90-05630

NOTE ON THE RATIONAL METHOD.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, and J. F. Cruise.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 78-87, 6 fig, 14 ref.

Descriptors: *Urban hydrology, *Storm runoff, *Watersheds, *Rainfall-runoff relationships, *Runoff forecasting, *Rational formula, Mathematical studies, Kuichling rational method, Hydrographs, Runoff coefficient, Channel flow, Flow, Probabilistic process, Reservoirs.

The rational method was evaluated by comparison with other methods and by practical applications. The following conclusions were drawn: (1) the rational method hypothesizes a watershed to be a linear, time-invariant system, with its instantaneous unit hydrograph given as a rectangular distribution of the base time equal to the time of concentration Consequently, the watershed is represented by a rectangular shape; (2) the abstractions are accounted for through the runoff coefficient. the effective rainfall-direct runoff relation is a one-parameter model for the rational method, where time of concentration is the parameter; (3) the rational method is a special case of the time-area and Soil Conservation Service methods; (4) no information about a watershed other than time of concentration is assumed. Consequently, the probability density function of the rational method is a uniform distribution, with entropy increasing with increasing value of time of concentration; and (5) by comparison with a linear reservoir, the rational method produces a lower peak by a factor equal to about 1.42. (See also W90-05621) (Cassar-PTT)
W90-05631

EVALUATION OF TC METHODS IN A SMALL RURAL WATERSHED.
Baker (Michael), Jr., Inc., Alexandria, VA.
T. G. Goitom.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 88-96, 2 fig, 3 tab, 17 ref.

Descriptors: *Rainfall-runoff relationships, *Arizona, *Runoff forecasting, *Watersheds, *Concentration time, *Rational formula, Kuichling rational method, *Channel flow, Flood peak, Rural areas, Hydrologic models, Mathematical studies, Walnut Gulch, Kirpich equation, California Culverts Practice, Papadakis-Kazan equation, Flow.

The time of concentration parameter used in hydrologic studies was computed with four empirical equations, using data from a 560-acre subwatershed in the semiarid Walnut Gulch Experimental Watershed in Arizona. Times of concentration (min) were as follows: Kirpich equation, 45; California Culverts Practice, 45; Papadakis-Kazan equation, 56; and Soil Conservation Service TR-55 procedure, 67. The Kirpich and California Culverts Practice were developed for well defined steep channel slopes and assumed that time of concentration was independent of rainfall intensity. In addition, the Kirpich equation used data from rural basins in Tennessee, while the California Culverts Practice was developed for small mountainous basins in California. Therefore, these two equations are not recommended for use in the Walnut Gulch Watershed. (See also W90-05621) (Cassar-PTT)
W90-05632

BASIN LAG AS A FUNCTION OF RAINFALL.
Missouri Dept. of Natural Resources, Rolla. Div. of Geology and Land Survey.
G. J. Swenty, and J. A. Westphal.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 97-106, 9 fig, 1 tab, 15 ref.

Descriptors: *Unit hydrographs, *Overland flow, *Storm runoff, *Rainfall-runoff relationships, *Runoff forecasting, Basins, Channel flow, Watersheds, Catchment basins, Hydrographs, Synthetic hydrology, Hysteresis, Hyetographs, Model studies, Mathematical studies, Flow, Temporal distribution.

Runoff from storms of various depths and two different durations (6 and 12 hr) and temporal distributions was simulated for a small, ungaged watershed in the Missouri Ozarks using the Storm Water Management Model. Temporal distributions included the 50-year and 100-year precipitation, the probable maximum precipitation (PMP), the 0.3 PMP, the 0.5 PMP, and the 0.75 PMP. Results indicated that, for a given temporal distribution of rainfall, basin lag (distance between centroids of the hyetograph of effective precipitation and the direct runoff hydrograph) could be expressed as a function of storm depth and the ratio of flow path length to square root of the flow path slope. A high degree of basin disaggregation was necessary to analyze this small basin. For example, a 10-acre maximum was required to limit the overland flow lengths to 500 ft. For both rainfall durations the simulated lag time decreased with increasing depth of precipitation. For a given rainfall depth the 12-hour lag times were greater than the 6-hour lag times. Using the traditional approach of combining the overland and channel flow lag times from the Kerby-Hathaway and Kirpich equations gave reasonable, but slightly low, estimates of basin lag time for 100% PMP events. For PMP less than 100%, underestimation was greater. (See also W90-05621) (Cassar-PTT)
W90-05633

RUNOFF COEFFICIENT RELATED TO CURVE NUMBER-SCS METHOD.
Institute of Environmental Protection, Warsaw (Poland).
A. Bielawski.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 107-110, 2 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff, *Rational formula, *Runoff coefficient, *Hydrologic models, *Urban hydrology, Kuichling rational method, Hydrographs, Unit hydrographs, Soil Conservation Service curve number, Poland, Model studies, Mathematical studies.

The runoff coefficient and curve number of the Soil Conservation Service method were correlated with gaged urban watersheds (1.73 to 697 hectares) and storm characteristics in urban drainage areas in Poland. The runoff coefficient varied from 0.2 to 0.58, and the curve number varied from 89.6 to 98.04. The correlation coefficient between the values of runoff coefficient and curve number was about 0.8. (See also W90-05621) (Cassar-PTT)
W90-05634

RELATIONS BETWEEN RATIONAL AND SCS RUNOFF COEFFICIENTS AND METHODS.
S. D. Graber.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 111-120, 3 fig, 1 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Storm runoff, *Rational formula, *Runoff coefficient, Soil Conservation Service curve number, Kuichling rational method, Graphical analysis, Mathematical studies.

Methods were developed for converting rational method runoff coefficient values to Soil Conservation Service method curve number values and vice versa. In selecting between the rational method and the several TR-55 SCS methods (graphical, chart, and tabular) it was necessary to balance between build-in objectivity (at the expense of accuracy) and the subjectivity associated with independent engineering judgment. In one example, a peak flow of 3.71 cfs for a 1.54-acre site was determined by the rational method. The rational method runoff coefficient of 0.574 was converted to a curve number value of 74.7. Using that curve number, a complete hydrograph was computed. Its peak flow was 3.77 cfs. (See also W90-05621) (Cassar-PTT)
W90-05635

RUNOFF COEFFICIENT AND SEDIMENT YIELD IN SMALL WATERSHEDS UNDER LAND-USE CHANGES IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Dept. of Soil and Water Conservation.
C.-H. Tuan.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 121-129, 15 tab, 4 ref.

Descriptors: *Watershed management, *Land use, *Sediment yield, *Rainfall-runoff relationships, *Runoff coefficient, *Taiwan, *Urbanization, Rational formula, Watersheds, Soil conservation, Revegetation, Environmental effects, Erosion.

The effects of land use and soil conservation measures on runoff coefficient and sediment yield were studied in four neighboring small watersheds (simulated housing development up to about 40%) of 0.5 ha for 5 yr, in a 3.7-ha watershed (orchard development) for 3 yr in, and in a 7.2-ha watershed (mixed housing, roads, orchard, with about 50% bamboo and brush) for 2 yr. The gross runoff coefficient, peak runoff coefficient, and sediment yield per unit area all increased with increasing degree of land development. All coefficients decreased when soil conservation measures using vegetation were employed. Sediment yields were also significantly reduced by use of natural vegetation and/or artificial revegetation in soil conservation. (See also W90-05621) (Cassar-PTT)
W90-05636

URBAN FLOOD RUNOFF MODELING USING MEASURED INFILTRATION CAPACITY OF VARIOUS LAND USES.
Tokyo Metropolitan Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4C.
W90-05637

SYNTHETIC HYDROGRAPH BASED ON KUICHLINGS AND MANNINGS FORMULAS.
Florida Univ., Gainesville. Dept. of Civil Engineering.
B. A. Christensen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 140-145, 2 fig, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, Routing, *Hydrographs, *Mannings equation, *Rational formula, Kuichling rational method, Mathematical studies, Reservoirs, Channel flow, Flow, Synthetic hydrographs, Storm runoff, Water storage, Storage, Flood peak, Runoff coefficient, Hydraulic roughness, Roughness coefficient.

A hydrograph for the runoff from small drainage basins was developed using a combination of Kuichlings rational method and Mannings formula and based on the drainage areas' functions of storing and conveying storm water. These two functions can then be separated and described by means of differential equations. This method provided information about the time history of the rate of runoff so that the runoff could be routed through reservoirs and channels, natural or man-made. (See also W90-05621) (Cassar-PTT)
W90-05638

STORM RUNOFF SIMULATIONS IN MATSUYAMA CITY DRAINAGE BASIN.
Kobe Univ. (Japan). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 4C.
W90-05639

COMPARISON OF RATIONAL AND SCS-TR55 METHODS FOR URBAN STORM WATER MANAGEMENT.
Boswell Engineering, South Hackensack, NJ.
For primary bibliographic entry see Field 4C.
W90-05640

SPATIAL RESOLUTION IN HYDROLOGIC MODELING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
T. Tao, and N. Kouwen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 166-175, 1 fig, 2 tab, 17 ref.

Descriptors: *Model studies, *Rainfall-runoff relationships, *Routing, *Flood routing, *Flood forecasting, *Runoff forecasting, Hydrologic models, Spatial resolution, Land use, Mathematical models, Grand River, Ontario, SIMPLE model, Watersheds.

The spatial resolution concerning land use/cover and other topographic characteristics in a physically based, distributed parameter flood forecasting model (SIMPLE) was studied. The study area was the Grand River, Ontario. Runoff was calculated separately for each land cover class in each element, and the modeling parameters were identical throughout the whole watershed for a particular land cover class. The river routing parameters were determined on the basis of sub-basins. Four rainfall events were used in the study. Two grid sizes (5 x 5 km and 10 x 10 km) were used in the simulations. Differences in grid sizes did not produce significant differences in flood forecasting simulation, provided that each element was properly described. (See also W90-05621) (Cassar-PTT)
W90-05641

TILT AT THE WINDMILL OF RUNOFF SIMULATION.
Missouri Univ.-Rolla. Dept. of Civil Engineering.
D. B. Thompson, and J. A. Westphal.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 176-185, 3 fig, 2 tab, 9 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Model studies, Mathematical studies, PRMS model, Precipitation-Runoff Modeling System, Watersheds, Hydrographs, Storm runoff, Flood peak, Hydrologic models.

A continuous simulation model, the U.S. Geological Survey Precipitation Runoff Modeling System, was evaluated using data from three small Missouri watersheds, for which calibration and verification data were available. It was impossible to reproduce daily values. Monthly values could be reproduced in a gross sense, but the standard deviation of residuals was large compared to mean monthly runoff. In the event-based mode, the mean of storm events was generally reproduced, but the model was unable to match either peaks or volumes of observed events. The model was considered useful as a research tool but deficient as an engineering design tool. (See also W90-05621) (Cassar-PTT)
W90-05642

COMPARISON OF SOME RAINFALL-RUNOFF MODELS FOR NONLINEAR FLOOD FORECASTING.
Utsunomiya Univ. (Japan). Dept. of Civil Engineering.
M. Hasebe, and M. Hino.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational-

al Formula. University of Virginia, Charlottesville, VA. 1989. p 186-195, 12 fig, 8 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Hydrologic models, *Flood forecasting, *Model studies, Mathematical studies, Forecasting, Flood peak, Unit hydrographs.

The filter separation AR method of Hino and Hasebe was compared with three other models for flood forecasting, using data from an experimental watershed. The three methods were a regression model, a unit hydrograph, and a quasi-physically based model proposed by Loague and Freeze. The filter separation AR method accurately predicted runoff, whereas the other three models significantly underpredicted peak heights. The regression model also predicted a peak about an hour later than observed. Modeling efficiencies of real time forecasting were compared; (1) the filter separation AR method, (2) the generalized storage function method to which Kalman filtering theory was applied, and (3) the tank model method. Errors of prediction for flood forecasting and for peak discharge were least when the filter separation AR method was used, compared with the other three models. (See also W90-05621) (Cassar-PTT)
W90-05643

NONLINEAR ANALYSIS OF RAINFALL AND RUNOFF PROCESS.
Kanazawa Inst. of Tech. (Japan). Dept. of Civil Engineering.
K. Mizumura.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 196-205, 6 fig, 5 ref.

Descriptors: *Overland flow, *Kinematic wave theory, *Hydrographs, *Routing, *Storm runoff, *Rainfall-runoff relationships, *Runoff forecasting, Nonlinear analysis, Model studies, Mathematical studies, Flow.

An analytic solution to the coupling of the kinematic wave overland flow routing problem and simple time-varying rainfall excess was developed. When the magnitude of the time-varying component of the rainfall excess was much smaller than the constant component of the rainfall excess, the nonlinear partial differential equation was linearized. The analytic solution of the linearized partial differential equation coincided with the nonlinearized solution of the nonlinear partial differential equation. An analytic solution was also obtained in the case of spatial variation in rainfall excess. Due to nonlinearity, the slope of the rising limb became steeper and the recession curve of the hydrograph for time-varying rainfall became less steep. Therefore, time to peak discharge decreased. (See also W90-05621) (Cassar-PTT)
W90-05644

MULTI-TANK MATRIX METHOD FOR RUNOFF.
Niigata Univ. (Japan). Dept. of Civil Engineering.
Y. Okamoto.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 206-215, 9 fig, 1 tab, 1 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, *Japan, *Model studies, Mathematical studies, Unit hydrographs, Hydrographs, Multi-tank matrix method, Watersheds, Mountains.

A runoff calculation method, Multi-Tank Matrix Method, was developed because the unit hydrograph method is not applicable to mountainous river basins in Japan. The new method requires no special hydrologic knowledge, it is applicable to basins with no hydrologic data, and it is fully automated. A wide range of flow volume is covered, and hourly changes can be incorporated. Inputs to the model are temperature and rainfall. Since the mountainous areas of Japan have very uneven rainfall distribution, it is necessary to limit the area represented by one rainfall gage to 20 to 30 sq km. The model is expected to predict flood discharge within 10%. (See also W90-05621) (Cassar-PTT)
W90-05645

APPLICATIONS OF THE MANNING'S AND RATIONAL FORMULAS FOR THE DESIGN OF STORM DRAINS IN SINGAPORE.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
E. B. Shuy.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 216-225, 2 fig, 2 tab, 9 ref.

Descriptors: *Design standards, *Rainfall-runoff relationships, *Hydraulic design, *Singapore, *Urban hydrology, *Runoff forecasting, *Drainage systems, *Storm runoff, *Rational formula, *Mannings equation, Kuichling rational method, Flood control, Flood peak, Runoff coefficient, Channel flow, Design criteria, Hydraulic design, Tidal effects, Hydraulic roughness, Roughness coefficient.

The extensive storm drainage system of flood-prone Singapore was designed using the rational and Manning's formulas. Extensive rechannelization has been done over the years in order to conduct the water to the sea as rapidly as possible. Flood plain zoning and flood detention ponds are rarely used because of space restrictions. Tidal gates are used in low-lying areas; however, they provide only a temporary solution until fill can be added to raise the ground level. Runoff coefficients calculated for Singapore are as follows: urban areas fully built up, 0.90; residential areas densely built up, 0.80; residential areas densely built up with rural areas, 0.65; and rural areas with fish ponds and vegetable gardens. 0.45. In using the rational formula, the partial area effect is sometimes encountered. This is often encountered at the junction of two main drains and where the subcatchments are large. This is accounted for by using a larger estimated peak runoff rate. In storm channel design a Manning's roughness coefficient of 0.015 is used for concrete channels; however, measured values, as influenced by sediment and algae, range between 0.012 to 0.035. Most of the channels are wide, shallow, and with a gentle bed gradient; in some cases the most efficient hydraulic cross sections are not feasible. The permissible design peak flow velocity is limited to 3 m/s, and the Froude number to <0.8. Tidal effects are assessed, and the channels are built to accommodate the steady state backwater profile created by the peak discharge coinciding with the highest tide level downstream. (See also W90-05621) (Cassar-PTT)
W90-05646

USE OF THE RATIONAL FORMULA IN INFILTRATING MOUNTAINOUS CATCHMENTS.
Sultan Qaboos Univ., Muscat (Oman). Dept. of Civil Engineering.
M. Nouh.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 226-237, 4 tab, 10 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff, *Infiltration, *Rational formula, *Saudi Arabia, *Storm runoff, Mathematical studies, Kuichling rational method, Flow, Temporal variation, Mountains, Catchment areas, Soil properties, Soil infiltration.

Data from 32 infiltrating mountainous catchments located in the southwest region of Saudi Arabia were used to test the accuracy of performance of the rational formula. The data were sorted according to parameters identifying size and shape of catchment, slope of land, characteristics of surface soils, and temporal and spatial variation of rainfall over the catchment. Several numerical measures were used to assess the accuracy. These measures included the ratio between the predicted and observed flowrate values, the standard deviation of the individual flowrate values about the overall mean, and the absolute error between the predicted and observed values expressed as a percentage of the observed value. The formula overestimated flowrates in the catchments. Its accuracy was sensitive to temporal rainstorm variation more than spatial rainstorm variation, and to slope of land and catchment size more than characteristics of soils. Although all the parameters affected the accuracy of flowrates prediction by the formula, size of catchment was the least important factor in case of low spatial variation of rainfall, and slope of land was the least important factor in case of small size catchments having high infiltration capability. The formula coefficient characteristic of the catchment was related to the characteristics of both rainfall and catchment, and a procedure was developed for best estimation of flowrates by the rational formula. (See also W90-05621) (Author's abstract)
W90-05647

DESIGN OF STORMWATER DETENTION BASINS. A SIMPLIFIED METHOD.
Rettew Associates, Inc., Lancaster, PA.
H. T. Solanki, and J. R. Weese.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 238-247, 2 fig, 10 ref.

Descriptors: *Urban hydrology, *Detention basins, *Rational formula, *Rainfall-runoff relationships, *Runoff forecasting, *Hydraulic design, *Storm runoff, Land use, Hydrographs, Urbanization, Design criteria, Rational formula, Kuichling rational method, Water storage, Weirs, Runoff coefficient, Flood peak.

A method was developed for calculation of detention basins so that storm runoff after development is approximately equal to pre-development runoff. The detention basin outlet structure was designed to provide for complete draining of the detention basin after a storm event. The storage volume was calculated by mathematically equating the storage volume with the difference between inflow and outflow volumes at the peak storage time. To calculate the peak runoff for the pre-development and post-development conditions, the rational formula was used. The outflow volume was calculated by using a rectangular weir formula. Assuming that the rising side of the outflow hydrograph was nearly parabolic, a coefficient of 0.62 was used in calculating the peak storage time. The time of concentration after development was related to the ratio of the pre-development and post-development runoff coefficient to the power of 0.47 times the time of concentration before development. (See also W90-05621) (Cassar-PTT)
W90-05648

LAGSTRUM AND NONLINEARITY OF HYDROLOGIC TIME SERIES.
Tamkang Univ., Taipei (Taiwan). Dept. of Water Resources and Environmental Engineering.
G.-H. Yu, and Y.-M. Wang.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 258-266, 18 fig, 1 tab, 11 ref. National Science Council, Republic of China, Grant NSC 76-0410-E032-05.

Descriptors: *Nonlinear series, *Rainfall-runoff relationships, *Hydrologic models, *Runoff forecasting, *Time series analysis, Lagstrum, Hinch method, Model studies, Mathematical studies, Synthetic hydrology, River flow, Channel flow.

The lagstrum approach described by Hinch was evaluated for detection of the nonlinearity of time series. This approach was successful in detecting the lag structure of a series which obeys a quadratic model. However, if the series does not obey a

quadratic model, nonlinearity might not be detected. It was suggested that the series be directly analyzed without transforming it to conform to a quadratic model. The Canadian lynx series (1821-1934) and monthly flows from two rivers in Taiwan were analyzed and found to be nonlinear. (See also W90-05621) (Cassar-PTT)
W90-05650

REGIONAL GEOHYDROLOGIC-GEOMORPHIC RELATIONSHIPS FOR THE ESTIMATION OF LOW-FLOWS.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
R. M. Vogel, C. N. Kroll, and K. M. Driscoll.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 267-277, 4 fig, 2 tab, 16 ref.

Descriptors: *Rainfall-runoff relationships, *Streamflow, *Surface-groundwater relations, *Base flow, *Low flow, *Geohydrology, Geomorphology, Base runoff, Flow, Drainage, Watersheds, Model studies, Mathematical studies, Hydrologic models, Hydraulic conductivity, Drainage, Groundwater movement, Aquifers, Soil porosity, Slopes.

A simple conceptual stream-aquifer model was developed and then transformed into a watershed model for low flow. The watershed system was treated as a linear reservoir, using 845 site-years of streamflow data available for 23 unregulated catchments in Massachusetts. After verifying the linear-reservoir hypothesis, the watershed model of low flow was adapted to low-flow statistics. Basin groundwater outflow was shown to be proportional to the product of basin hydraulic conductivity, drainage area, average basin slope, and the baseflow recession constant, acting as a surrogate for both basin hydraulic conductivity and drainable soil porosity. Estimated regional regression equations between the 7-day 2-year and 7-day 10-year low-flow statistics, and the independent variables (drainage area, average basin slope, and baseflow recession constant) had standard errors of estimate equal to 10.2% and 26.5%, respectively. The regressions developed required estimates of the baseflow recession constant, which was derived from a short sample of data or from a map. (See also W90-05621) (Cassar-PTT)
W90-05651

STOCHASTIC MODELS IN HYDROMORPHOLOGY.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
Y. V. Pissarev.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 278-284, 3 tab.

Descriptors: *Channel morphology, *Geomorphology, *Rainfall-runoff relationships, *Rivers, *Model studies, Mathematical studies, Stochastic process, Hydrographs, River flow, Runoff, River beds, Probabilistic process.

Randomness was considered in methods for studying river flow and morphology. The stochastic process was applied for design purposes. The calculation included three basic parts: (1) stochastic--modeling of the long-term river runoff hydrograph with corresponding distribution of the discharge probabilities; (2) determinate--use of the long-term runoff hydrograph for calculations of hydraulic and morphologic characteristics, i.e., a one-dimensional or a two-dimensional problem is solved; (3) statistical--processing of the sequence of occurrence of the characteristics calculated using statistical methods and probability theory. (See also W90-05621) (Cassar-PTT)
W90-05652

PAVEMENT DRAINAGE DESIGN USING YEN AND CHOW RAINFALL.
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
A. O. Akan.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 285-291, 3 fig, 1 tab, 4 ref.

Descriptors: *Urban hydrology, *Pavement hydraulics, *Rainfall-runoff relationships, *Runoff forecasting, *Design criteria, *Highways, *Drainage engineering, *Overland flow, Model studies, Mathematical studies, Roads, Impervious surfaces, Kinematic wave model, Rainfall intensity, Flood peak, Precipitation, Drains, Storm runoff.

A peak discharge chart was developed using a kinematic wave model for overland and gutter flow components of a pavement drainage process, the concept of hydrologic similarity, and the Yen and Chow triangular rainfall distribution. The peak discharge chart, with its dimensionless parameters, was used in a sample application: a highway in Norfolk, Virginia, with a width of 32 ft and slope of 0.03. The gutter was 600 ft long with a longitudinal slope of 0.005. A chart of average rainfall intensity versus rainfall duration showed curves for return periods of 2, 10, and 50 years. At the 10-year return period, the maximum peak discharge was 3.4 cfs, produced by a design rainfall of 15 min and 5 in/hr average intensity. (See also W90-05621) (Cassar-PTT)
W90-05653

SURFACE RUNOFF FROM TURFED AREA IN THE TROPICS.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
Y. M. Chiew, and S. K. Tan.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 292-298, 3 fig, 1 tab, 5 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff, *Tropical regions, *Overland flow, *Surface runoff, Turf grasses, Grasses, Infiltration, Mannings equation, Roughness coefficient, Hydraulic roughness, Precipitation, Hydrographs, Rainfall intensity, Vegetation, Singapore.

Surface runoff from two turfed slopes in Singapore was studied to establish data for tropical regions. Experimental plots A and B had the following characteristics, respectively: average slope, 0.5 and 0.35; paved area of catchment, 238 and zero sq m; turfed area of catchment, 1017 and 2056 sq m; vegetation, sparse and thick grass; soil porosity, both 49%. The sparse and coarse grass on plot A allowed the runoff to flow with less interference as compared with the thick grass of plot B. In plot A runoff from trimmed and untrimmed grass were compared. The untrimmed grass, which allowed some infiltration, had 10% less runoff than the trimmed grass, where the water tended to flow over the surface. Mannings numbers for the plots varied between 0.079 to 0.114 (mean, 0.94) for a flow depth of 7 to 16 mm. The ratio of runoff volume over total rainfall was plotted as a function of rainfall intensity. This ratio increased rapidly with increase in rainfall intensity until a maximum at 5 mm/hr. Thereafter, it decreased until a constant was reached at 50 mm/hr. (See also W90-05621) (Cassar-PTT)
W90-05654

APPLICABILITY OF MANNING'S N VALUES FOR SHALLOW OVERLAND FLOW.
Agricultural Research Service, Beltsville, MD. Hydrology Lab.
E. T. Engman.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 299-308, 2 fig, 1 tab, 19 ref.

Descriptors: *Rainfall-runoff relationships, *Mannings equation, *Runoff, *Overland flow, Roughness coefficient, Hydraulic roughness, Sediment transport, Shallow water, Channel flow, Friction.

Hydraulic roughness coefficients were derived from runoff plot data involving different agricultural and natural surfaces by applying constant rainfall rates from rainfall simulators. The derived roughness coefficient included the effect of raindrop impact; the effect of channelization of flow; the effects of obstacles such as litter, crop ridges, rocks, and tillage roughness; the fractional drag over the surface; and the erosion and transport of sediment. Manning's n values were calculated by kinematic wave analysis and by storage volume analysis. (See also W90-05621) (Cassar-PTT)
W90-05655

ARTIFICIAL RAINFALL FOR PAVEMENT RUNOFF STUDIES.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
J. R. Reed, and D. F. Kibler.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 309-318, 4 fig, 2 tab, 11 ref. U.S. Federal Highway Administration Contract DTFH61-80-C-00049.

Descriptors: *Data acquisition, *Pavement hydraulics, *Roads, *Hydroplaning, *Simulated rainfall, *Precipitation, *Rainfall simulators, *Runoff, Data collections, Impervious surfaces, Surface runoff.

Inexpensive, portable rainfall simulation equipment was developed for studies aimed at measuring runoff depths associated with hydroplaning on roads. The system provides a uniform rain of given intensity on an area of 15 ft x 30 ft. It consists of two modules, each 15 x 15 ft, in order to span one or two lanes of a 12-ft wide road. The corner of each module is a metal tripod which supports metal piping leading to a spray-up nozzle (Rainbird 1800 quarter-circle), which is preceded by a pressure gage, pressure regulator, gate valve, and bleed valve. The nozzles can be placed at heights between 4 and 6 ft. The swivel pads on the tripod legs allow levelling on a sloping surface. Control of drop size was not incorporated into the equipment. The simulator was used outdoors on highways and indoors on a permanent pavement test area. (See also W90-05621) (Cassar-PTT)
W90-05656

RESISTANCE TO RAINFALL-RUNOFF ON A TEXTURED SURFACE.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
J. R. Reed, D. F. Kibler, and G. A. Krallis.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 319-324, 1 fig, 6 ref. U.S. Federal Aviation Administration Contract N68335-86-C-1131.

Descriptors: *Hydroplaning, *Runways, *Pavement hydraulics, *Laminar flow, *Rainfall-runoff relationships, *Runoff, *Mannings equation, Precipitation, Surface flow, Surface runoff, Roads, Impervious surfaces, Roughness coefficient, Hydraulic roughness.

Experiments aimed at predicting sheet flow runoff depths on pavement were conducted on a concrete surface sloping at 1.5% and having a mean texture depth of 0.0215 in. The surface was subjected to rainfall intensities of 1.0 and 2.5 in per hour. Resulting runoff depths measured remotely by pressure transducer at six downstream locations ranged between 0.03 and 0.09 in. Manning's n values were inversely and nonlinearly proportional to the runoff depth. Values of n were 0.24 to 0.65, much greater than typical values of relative roughnesses on a Moody diagram for pipe flow where a maximum relative roughness value of 0.05 extends from the completely rough flow range almost into the

laminar flow range. (See also W90-05621) (Cassar-PTT)
W90-05657

PREDICTING STREAM VELOCITIES IN A NAVIGATION CHANNEL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05659

MANNING'S EQUATION AND VELOCITY DISTRIBUTION IN OPEN CHANNELS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05660

DIRECT APPLICABILITY OF THE CHEZY FORMULA TO NATURAL CHANNELS.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
For primary bibliographic entry see Field 8B.
W90-05661

CHANNEL RESISTANCE AT THE SIDE-WEIR LOCATION IN OPEN CHANNEL FLOW.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05663

ESTIMATION OF MANNING'S ROUGHNESS COEFFICIENT IN ALLUVIAL STREAMS.
Queen's Univ., Belfast (Northern Ireland). Dept. of Agriculture for Northern Ireland.
For primary bibliographic entry see Field 8B.
W90-05664

NONLINEAR RESISTANCE RELATIONSHIPS FOR ALLUVIAL CHANNELS.
Interstate Commission on the Potomac River Basin, Rockville, MD.
For primary bibliographic entry see Field 8B.
W90-05665

ALLUVIAL STREAM HYDRAULIC RESISTANCE IN THE PRESENCE OF FILTRATION.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. K. Debolsky, and D. O. Gubeladze.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 400-409, 2 fig, 1 tab, 8 ref.

Descriptors: *Streamflow, *Hydraulics, *Alluvial channels, *Channel flow, *Hydraulic friction, Filtration, Sediments, Bed load, Reynolds number, Storm seepage, Flow velocity, Velocity distribution, Permeability, Mathematical studies, Streambeds.

The subsurface flow beneath alluvial river beds and its influence on hydraulic resistance was studied. The main flow velocities were measured at different ground permeability characteristics. Data showed that the main flow velocity distribution was described by a power law with a variable exponent dependent on ground permeability characteristics and flow parameters. The flow immediately under the ground surface of the main flow had a velocity greater than the filtration velocity. The dimensionless complex analogous to the Reynolds number, which takes into account ground filtration characteristics, allowed generalization of data on hydraulic resistance. However, at flow velocities near to the critical values, hydraulic resistance coefficients of the streams were not uniform. (See also W90-05621) (Cassar-PTT)
W90-05666

SAND-BED CHANNEL HYDRAULIC RESISTANCE ESTIMATION.
People's Friendship Univ., Moscow (USSR).
For primary bibliographic entry see Field 8B.
W90-05668

DIMENSIONLESS MANNING-TYPE EQUATION.
Cincinnati Univ., OH.
For primary bibliographic entry see Field 8B.
W90-05671

GENERALIZED FORMULA FOR THE CHEZY COEFFICIENT FOR THE RIVER FLOW.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
For primary bibliographic entry see Field 8B.
W90-05672

BACKWATER COMPUTATION OF NATURAL RIVERS WITH EXTREME BANK OR FLOODPLAIN ROUGHNESS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
E. Ritterbach, and G. Rouve.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 468-477, 7 fig, 2 tab, 8 ref.

Descriptors: *Backwater, *Flood hydraulics, *River flow, *Flood forecasting, *Flood plains, Banks, Shear stress, Turbulent flow, Flow resistance, Roughness coefficient, Backwater effect, Hydraulic roughness, Model studies, Mathematical studies, Water depth, Flood protection, Vegetation, Sieg River, Wupper River, West Germany.

A one-dimensional model (ESNA) was developed for predicting water surface elevation in natural rivers with trees and bushes on the banks and flood plains. The model divided each river cross section into several subsections, regarding the turbulent shear stresses as apparent wall shear stresses. The model was applied first to a 7-km stretch of a natural plain-country river, Sieg, in West Germany. Prediction of a flood event was within 3 cm (1.1%) of measured water levels. The model was calibrated with data collected on a 75-km stretch of the extremely heterogeneous river Wupper in the hill country, dividing the river into 1000 cross sections. Agreement between calculated and measured data was very good. (See also W90-05621) (Cassar-PTT)
W90-05673

EXAMINATION OF STAGE-DISCHARGE RELATIONSHIPS OF COMPOUND/COMPOSITE CHANNELS.
WEST Consultants, Inc., San Diego, CA.
For primary bibliographic entry see Field 8B.
W90-05674

MODEL-PROTOTYPE COMPARISONS OF BOUNDARY RESISTANCE IN A TWO STAGE CHANNEL.
Queen's Univ., Belfast (Northern Ireland).
For primary bibliographic entry see Field 8B.
W90-05675

MOMENTUM TRANSFER IN COMPOUND CHANNELS.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05676

COMPOUND CHANNEL FROUDE NUMBER FOR MANNING'S N VARIABLE WITH DEPTH.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05677

MANNING'S N OF COMPOSITE ROUGHNESS IN CHANNELS OF SIMPLE CROSS-SECTION.
City Univ., London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05678

EFFECTS OF ASPECT RATIO AND SIDE-WALL ROUGHNESS ON VELOCITY DISTRIBUTION AND RESISTANCE COEFFICIENT IN RECTANGULAR OPEN CHANNELS.
Tsinghua Univ., Beijing (China). Dept. of Hydraulic Engineering.
For primary bibliographic entry see Field 8B.
W90-05679

EFFECTS OF AN ICE COVER ON THE COMPOSITE VALUE OF MANNING'S N.
Michigan Technological Univ., Houghton. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2C.
W90-05680

REPLACING THE HYDRAULIC RADIUS IN MANNINGS FORMULA.
Florida Univ., Gainesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05681

PHYSICALLY BASED MODEL FOR DETERMINING FLOW RESISTANCE AND VELOCITY PROFILES IN VEGETATED CHANNELS.
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 8B.
W90-05682

DETERMINATION OF MANNING'S N AND FRICTION FACTOR IN VEGETATED WATERWAYS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 8B.
W90-05684

FACTORS AFFECTING ROUGHNESS COEFFICIENT IN VEGETATED CHANNELS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05685

HYDRAULICS RESEARCH IN MOUNTAIN RIVERS.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 8B.
W90-05686

STUDY ON THE MANNING'S ROUGHNESS COEFFICIENT OF STEEP MOUNTAINOUS STREAMS IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Graduate Inst. of Soil and Water Conservation.
For primary bibliographic entry see Field 8B.
W90-05687

FROUDE NUMBER IN THE EVALUATION OF THE FRICTION FACTOR IN THE NATURAL RIVERS.
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
For primary bibliographic entry see Field 8B.
W90-05688

MANNING'S N IN GRAVEL BED RIVERS.
Pahlavi Univ., Shiraz (Iran). Dept. of Irrigation.
For primary bibliographic entry see Field 8B.
W90-05689

RIFFLE-POOL FORMATIONS IN NORTHERN IRELAND RIVERS.
Department of Agriculture for Northern Ireland,

Belfast.
For primary bibliographic entry see Field 8B.
W90-05690

COMPARISON OF VELOCITY MEASUREMENTS IN STRAIGHT, SINGLE MEANDER AND MULTIPLE MEANDER COMPOUND CHANNELS.
University Coll., Cork (Ireland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05691

COMPARISON OF TURBULENCE MEASUREMENTS IN STRAIGHT, SINGLE MEANDER AND MULTIPLE MEANDER COMPOUND CHANNELS.
University Coll., Cork (Ireland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05692

EFFECTS OF DIFFERENTLY SHAPED OBSTACLES ON A RAPID STREAM EXPANSION.
Basilicata Univ., Potenza (Italy). Inst. of Hydraulics and Hydraulic Construction.
For primary bibliographic entry see Field 8B.
W90-05694

FRICTIONAL RESISTANCE TREATMENT IN UNSTEADY OPEN-CHANNEL FLOW SIMULATION.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 8B.
W90-05695

FLOOD ROUTING MODELS AND THE MANNING N.
National Weather Service, Silver Spring, MD. Hydrologic Research Lab.
For primary bibliographic entry see Field 8B.
W90-05696

ESTIMATION OF THE MANNING-STRICKLER ROUGHNESS COEFFICIENT IN SAINT-VENANT EQUATIONS.
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 8B.
W90-05697

TWO-DIMENSIONAL HIGH SPEED OPEN CHANNEL FLOW FRICTION EFFECTS.
Demokritos Univ. of Thrace, Xanthi (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05699

TRANSIENT CHANNEL FLOW ROUTING USING FIXED-POINT ITERATION METHOD.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.
For primary bibliographic entry see Field 8B.
W90-05700

GENERAL APPROACH TO SIMPLIFIED LINEAR ST. VENANT MODELS.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
W. G. Strupczewski, and R. J. Romanowicz.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 749-758, 9 ref.

Descriptors: *Flood routing, *Open-channel flow, *Channel flow, *Flood flow, *Streamflow, *Model studies, Mathematical studies, St Venant equation, Unit hydrographs, Uniform flow, Unsteady flow.

The substitution rules for the formulation of simplified floodrouting models derived from the linearized St. Venant equation for the case of a uniform open channel with an arbitrary cross section and friction law are given. The characteristic equation for deriving the cumulants of the IUH is used, which is applicable when one boundary condition is active. The paper method for evaluation of cumulants which allows one to formulate the substitution rules for the second order derivatives of the linearized St. Venant equation under the conditions of cumulants equivalence is introduced. Depending on the number of equivalent cumulants, three classes of approximating based on St. Venant equation models are distinguished; all having the simplest possible structure. The families of simplified models belonging to each class were derived using the substitution rules. (See also W90-05621) (Cassar-PTT)
W90-05701

STUDY ON THE LINEARIZED ANALYTICAL AND NUMERICAL SOLUTION FOR UNSTEADY OPEN CHANNEL FLOW.
Tamkang Univ., Taipei (Taiwan). Dept. of Water Resources and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W90-05702

UNCERTAINTY ON TRAVEL TIME IN KINEMATIC WAVE CHANNEL ROUTING.
Wyoming Water Research Center, Laramie.
For primary bibliographic entry see Field 8B.
W90-05703

OPEN CHANNEL FLOW IDENTIFICATION. CASE STUDIES.
Rijkswaterstaat-Deltadienst, Rijswijk (Netherlands). Data Processing Div.
For primary bibliographic entry see Field 8B.
W90-05704

POWER LAW OF FLOW RESISTANCE IN OPEN CHANNELS, MANNING'S FORMULA REVISITED.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 8B.
W90-05708

MANNING FORMULA IN CONTEXT.
University Coll., Dublin (Ireland). Centre for Water Resources Research.
For primary bibliographic entry see Field 8B.
W90-05709

RUNOFF CURVE NUMBERS. THE NEXT STEP.
Soil Conservation Service, Washington, DC. Engineering Div.
For primary bibliographic entry see Field 2A.
W90-05711

ASSESSMENT OF STREAM ACIDIFICATION IN THE CATSKILL MOUNTAINS OF NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05734

FLOOD BOUNDARIES AND WATER-SURFACE PROFILE FOR THE COMPUTED 100-YEAR FLOOD, SWIFT CREEK AT AFTON, WYOMING, 1986.
Geological Survey, Cheyenne, WY. Water Resources Div.
J. G. Rankl, and J. C. Wallace.
Available from Books and Open File Report Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4064, 1989. 2p, 27 fig, 1 tab, 1 map, 7 ref.

Descriptors: *Wyoming, *Surface water, *Maps, *Swift Creek, *Flood flow, *Flood peak, Flood plains, Streamflow.

Flood flows on Swift Creek near Afton, Wyoming, were analyzed. Peak discharge with an average recurrence interval of 100 years was computed and used to determine the flood boundaries and water surface profile in the study reach. The study was done in cooperation with Lincoln County and the Town of Afton to determine the extent of flooding in the Town of Afton from a 100-year flood on Swift Creek. The reach of Swift Creek considered in the analysis extends upstream from the culvert at Allred County Road No. 12-135 to the US Geological Survey streamflow-gaging station located in the Bridger National Forest, a distance of 3.2 miles. Boundaries of the 100-year flood are delineated on a map using the computed elevation of the flood at each cross section, survey data, and a 1983 aerial photograph. The computed water surface elevation for the 100-year flood was plotted at each cross section, then the lateral extent of the flood was transferred to the flood map. Boundaries between cross sections were sketched using information taken from the aerial photograph. Areas that are inundated, but not part of the active flow, are designated on the cross sections. (Lantz-PTT)
W90-05743

NATIONAL RESEARCH PROGRAM OF THE WATER RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY, FISCAL YEAR 1988.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 9D.
W90-05744

ALUMINIUM DIS-EQUILIBRIUM SOLUBILITY CONTROLS IN SCOTTISH ACIDIC CATCHMENTS.
Macaulay Land Use Research Inst., Aberdeen (Scotland).
For primary bibliographic entry see Field 5B.
W90-05836

LINEAR FLOOD ROUTING MODEL FOR RAPID FLOW.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
W. G. Strupczewski, and J. J. Napiorkowski.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 1, p 49-64, February 1990. 6 fig, 10 ref, 2 append.

Descriptors: *Flood forecasting, *Flood routing, *Flow models, *Model studies, *Rainfall-runoff relationships, *Streamflow, Froude number, Rapid flow model, St Venant equation.

The linear flood routing model presented was derived from the linearized St. Venant equation for the case of a uniform open channel with arbitrary cross-sectional shape and friction law. In order to filter out the downstream boundary condition the kinematic wave solution was used to approximate the diffusion term in the St. Venant equation. The hydrodynamic model obtained is called the rapid flow model (RFM). It provides the exact solution for a Froude number equal to one. Such characteristics of the RFM impulse response as cumulants, amplitude and phase spectra are analyzed, and then compared with those of the complete linearized St. Venant equations for different reach lengths, values of Froude number and frequencies of flood waves. The RFM can be applied for mountainous rivers that have large Froude numbers and both quick and slow rising waves. (Author's abstract)
W90-05838

WHAT IS THE DISTRIBUTED DELAYED MUSKINGUM MODEL.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
W. G. Strupczewski, and J. J. Napiorkowski.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 1, p 65-78, February 1990. 4 fig, 12 ref.

Descriptors: *Flood forecasting, *Flood routing, *Flow models, *Model studies, *Rainfall-runoff relationships, *Streamflow, Froude number, Muskingum model, Rapid flow model, St Venant equation.

A gap between hydrodynamic modeling and conceptual modeling of flood routing has been filled by the introduction of conceptual elements. The conceptual model gives results equivalent to those of the complete linearized Saint Venant equations for Froude number equal to one and approximately so in that vicinity. It has been applied to the case of a uniform open channel with arbitrary cross section and friction law. Pure lag has been introduced to the Muskingum model and then such models with physically based parameters have been coupled in series forming a multiple delayed Muskingum model. The asymptotic case, for a finite river reach, when the number of submodels tends to infinity, gives the distributed delayed Muskingum model. Further, this model is a particular solution of the complete linearized Saint Venant equations known as the rapid flow model. The model not only originates from conceptual elements but its impulse response has a clear conceptual interpretation. (Author's abstract)
W90-05839

COMPARISON OF PARAMETRIC AND NON-PARAMETRIC METHODS FOR RUNOFF FORECASTING.
Centro di Ricerca Idraulica e Strutturale, Milan (Italy).
G. Galeati.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 1, p 79-94, February 1990. 7 fig, 3 tab, 16 ref.

Descriptors: *Hydrologic models, *Italy, *Model studies, *Mountain streams, *Parametric hydrology, *Rainfall-runoff relationships, *Runoff forecasting, Autoregressive models, Hydroelectric power, Nearest neighbor method, Snowmelt, Stream discharge.

The performance of a non-parametric scheme, the nearest neighbor (NN) method, in predicting the daily mean discharge in a mountain basin supplying a hydroelectric reservoir in northeastern Italy were evaluated. The results were compared with those of an autoregressive model with exogenous input, coupled with a previously developed snow cover evolution, model. Both methods give good performances, but the NN prediction requires a much simpler simulation structure. In the case investigated, for example, the snowpack accumulation-melting model can be completely eliminated. This greater simplification assumes considerable importance in Electric Load Distribution Institutes of the Italian National Electricity Board, where many hydroelectric basins are managed every day. (Author's abstract)
W90-05840

DECISION MAKING FOR MULTIPLE UTILIZATION OF WATER RESOURCES IN NEW ZEALAND.
Otago Univ., Dunedin (New Zealand). Dept. of Geography.
For primary bibliographic entry see Field 6A.
W90-05862

NEW PRACTICAL AID TO REGIONAL HYDROGEOLOGIC PLANNING: THE RUNOFF COEFFICIENT MAP.
Siena Univ. (Italy). Dipt. di Scienze delle Terra.
P. Barazzuoli, S. Izzo, P. Menicori, M. Micheluccini, and M. Salleolini.
Environmental Management EMNGDC, Vol. 13, No. 5, p 613-622, September/October 1989. 3 fig, 5 tab, 10 ref.

Descriptors: *Geohydrology, *Rainfall-runoff relationships, *Runoff, *Runoff forecasting, Mapping, Permeability, Regional planning, Slopes, Vegetation, Watersheds.

Water-budget estimation was studied in particularly indeterminate conditions, in which absence or insufficiency of hydrographic instrumentation prevents the adequate evaluation of runoff. Techniques were developed based on the method of Kennessey, in which the runoff coefficient of a watershed in estimated using three physiographic variables (slope angle, permeability, and vegetation cover) and a parameter that defines the climatic conditions of the local area. Comparison of the Kennessey method with instrumental records from a wide variety of instrumented drainage basins in central Italy shows that the method provides reliable estimates of runoff. The analysis also indicates the best criteria for its application. This research enables a new application of the method, namely the runoff coefficient map, which, in addition to its specific usefulness for the evaluation of runoff, has three advantages. First, it supplies a more realistic vision of the local distribution of runoff/rainfall ratios; second it allows the spatial constraints imposed by the narrow frame of reference represented by the watershed to be overcome; and third, it makes an important contribution to the solution of other hydrogeological problems, such as the evaluation of the amount of water required for adequate recharge of the intake areas of deep aquifers or the maintenance of geothermal processes. Hence, this mapping technique is proposed as a valuable practical aid to regional hydrogeologic planning. (Author's abstract)
W90-05864

DEVELOPMENT OF A MIXED SOLUTION TECHNIQUE FOR A DYNAMIC RIVER QUALITY MODEL.
Salford Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-05870

SELECTIVE LUMPING EFFECTS ON DEPTH-INTEGRATED FINITE ELEMENT MODEL OF CHANNEL FLOW.
Mississippi Univ., University. Dept. of Mechanical Engineering.
J. Yue.
Advances in Water Resources AWREDI, Vol. 12, No. 2, p74-78, June 1989. 6 fig, 7 ref.

Descriptors: *Channel flow, *Finite element method, *Mathematical models, *Water depth, Channels, Computer models, Eddies, Hydraulic engineering, Numerical analysis.

The depth-integrated finite element model for water flow was derived from the three-dimensional Navier-Stokes equation by integrating and taking an average along water depth. Because it is much simpler than a three-dimensional model and saves computing time, it has been widely applied to many engineering problems, especially the shallow water current and wave motion in coastal regions. In applying the depth-integrated finite element model to solve river and basin water flow problems, matrix lumping techniques are widely employed for the benefits of eliminating matrix inverse and economizing computing time. The possible effects introduced by lumping simplification cause concern in engineering applications. A numerical simulation of straight channel flow provides a method of comparing lumped model results with unlumped model results to investigate the effects introduced by the lumping scheme. These effects include the influence of the selective lumping parameter on stability, numerical damping, Chezy coefficient, and eddy viscosity. Results of the comparison indicate that the lumping scheme not only simplifies solution procedure and saves computing time, but also improves stability. The numerical damping effect is negligible for a large range of lumping parameters, and the simple lumping scheme gives a better simulation of the theoretical solution than the unlumped model. (Tappert-PTT)
W90-05885

RELATIONSHIP BETWEEN BODY LENGTH PARAMETERS AND DRY MASS IN RUNNING WATER INVERTEBRATES.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
For primary bibliographic entry see Field 2H.
W90-05922

TRANSFORMATION AND LOSS OF NITRATE IN AN AGRICULTURAL STREAM.
Iowa State Univ., Ames. Dept. of Botany.
For primary bibliographic entry see Field 5B.
W90-05926

MICRO-BIOASSAY FOR EPILITHON USING NUTRIENT-DIFFUSING ARTIFICIAL SUBSTRATA.
Cincinnati Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-05931

AUTOTROPHIC-HETEROTROPHIC COMMUNITY METABOLISM RELATIONSHIPS OF A WOODLAND STREAM.
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
D. K. King, and K. W. Cummins.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 205-218, December 1989. 3 tab, 55 ref. Department of Energy Grant DE-AT06-79EV1004.

Descriptors: *Aquatic productivity, *Forest ecosystems, *Metabolism, *Respiration, *Stream biota, Chamber oxygen method, Forests, Meadows, Michigan, Riffles.

Using an in situ chamber oxygen method at five first through third order stream riffle sites in Augusta Creek, Michigan, estimates of community metabolism were made on a monthly or seasonal basis (1973-1975). Net community productivity ranged from -0.25 to 4.03 g O2/square meter/day, community respiration from 0.24 to 3.67 g O2/square meter/day, and gross community productivity from 0.09 to 5.35 g O2/square meter/day. The integrative parameters net daily metabolism ranged from -0.72 to 2.68 g O2/square meter/day and the ratio of gross community productivity to 24 hour community respiration ranged from 0.017 to 2.5 g O2/square meter/day, and remained relatively constant at each site. Most parameters were consistently low and stable at first order sites, while autotrophic sites differed significantly. The first order sites were heterotrophic with negative net daily metabolism. The meadow second order site was autotrophic with little capacity for export, illustrated by low net daily metabolism. Both third order sites (wooded and cleared) were autotrophic, but the cleared site had a higher net daily metabolism. (See also W90-05933 and W90-05934) (Author's abstract)
W90-05932

FACTORS AFFECTING AUTOTROPHIC-HETEROTROPHIC RELATIONSHIPS OF A WOODLAND STREAM.
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-05933

ESTIMATES OF DETRITAL AND EPILITHON COMMUNITY METABOLISM FROM PARTICLE-SIZED RIFFLE SEDIMENTS OF A WOODLAND STREAM.
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-05934

PLANARIANS IN TOXICOLOGY: I. PHYSIOLOGY OF SEXUAL-ONLY DUGESIA DOROTOCEPHALA: EFFECTS OF DIET AND POPULATION DENSITY ON ADULT WEIGHT AND COCOON PRODUCTION.
Illinois Univ. at Urbana-Champaign. Dept. of Veterinary Biosciences.
For primary bibliographic entry see Field 5A.
W90-05943

SOURCES AND ROUTING OF THE AMAZON RIVER FLOOD WAVE.
Washington Univ., Seattle. School of Oceanography.
J. E. Richey, L. A. K. Mertes, T. Dunne, R. L.

Victoria, and B. R. Forsberg.
Global Biogeochemical Cycles GBCYEP, Vol. 3, No. 3, p 191-204, September 1989. 7 fig, 3 tab, 43 ref. NSF Grant BSR-8107522. International Atomic Energy Agency BRA/0/010-08.

Descriptors: *Amazon River, *Flood discharge, *Flood hydrographs, *Flood routing, *Flood waves, *Routing, Flood peak, Flood plains, Model studies.

The sources and routing of the Amazon River flood wave was examined through a 2000-km reach of the main channel, between Sao Paulo de Olivenca and Obidos, Brazil. The sampled hydrograph of the main stem reflects the large drainage basin area, the 3-mo phase lag in peak flows between the north and south draining tributaries due to seasonal differences in precipitation, and the large volume of water stored on the flood plain. Several aspects of the valley floor hydrology that are important for biogeochemistry were examined, including volumes of water storage in the channel and the flood plain and the rates of transfer between these two storage elements at various seasons and in each segment of the valley. It was estimated that up to 30% of the water in the main stem is derived from water that has passed through the flood plain. To predict the discharge at any cross section within the study reach, the Muskingum formula was used to predict the hydrography at downriver cross sections from a known hydrograph at upstream cross-sections and inputs and outputs along each reach. The model was calibrated using three years of data and was successfully tested against an additional 6 yr of data. With this model it is possible to interpolate discharges for unsampled times and sites. (Author's abstract)
W90-05949

CONTINENTAL SCALE MODELS OF WATER BALANCE AND FLUVIAL TRANSPORT: AN APPLICATION TO SOUTH AMERICA.
New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans and Space.
For primary bibliographic entry see Field 2A.
W90-05951

TWO-DIMENSIONAL MIXING IN RIVERS WITH UNSTEADY POLLUTANT SOURCE.
Ryerson Polytechnical Inst., Toronto (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-05960

SEASONAL VARIATIONS OF WATER CHEMISTRY IN OLIGOTROPHIC STREAMS AND RIVERS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 2K.
W90-05986

SEASONAL PATTERNS OF MINERAL AND ORGANIC ACIDIFICATION IN TWO STREAMS IN SOUTHWESTERN NOVA SCOTIA.
Inland Waters Directorate, Moncton (New Brunswick). Water Quality Branch.
G. D. Howell.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 165-175, July/August 1989. 8 fig, 1 tab, 19 ref.

Descriptors: *Acid rain, *Acid streams, *Canada, *Chemical properties, *Organic acids, *Seasonal variation, *Streams, Acidity, Color, Hydrogen ion concentration, Kejimkujik National Park, Nova Scotia, Precipitation, Sulfates, Water quality.

Water quality data was examined for two highly colored streams located in and near to Kejimkujik National Park, in southwestern Nova Scotia. Moose Pit Brook is a small, low order stream with a drainage area of approximately 16.7 square km and dissolved organic carbon concentrations typically in the range of 7 to 40 mg/L. This stream has been sampled weekly since 1983. The Mersey River is a moderately colored (dissolved organic carbon range of 5-20 mg/L), high order system (drainage area of 295 square km) and has been sampled at varying intervals since 1979. Dissolved organic carbon concentrations in two streams of different hydrologic order are highly variable with the higher order stream exhibiting approximately a 3 month response lag. Seasonal variation of SO4 concentration and flux are similar in both streams and do not reflect the seasonal patterns in precipitation. The basins store SO4 from May to November and lose SO4 from December to April. Consequently, SO4 concentrations and flux are maximum during January to March and reach a minimum during July to September. The highly organic lower order stream exhibits relatively stable pH controlled by two competing mechanisms. The pH is dominated by organic acids during the summer and autumn and by mineral acids during the late winter and early spring. In the higher order system, the pH tends to be inversely related to changes in SO4 concentration. These observations suggest that organic systems do respond to acidic deposition but that in some systems mineral acid influence may be restricted to the winter and spring. (Mertz-PTT)
W90-05989

ECOLOGICAL AND PHYSIOLOGICAL RESPONSES OF ATLANTIC SALMON IN ACIDIC ORGANIC RIVERS OF NOVA SCOTIA, CANADA.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
For primary bibliographic entry see Field 2H.
W90-06007

RELATIONSHIP BETWEEN ARCTIC SEA-ICE ANOMALIES AND FLUCTUATIONS IN NORTHERN CANADIAN AIR TEMPERATURE AND RIVER DISCHARGE.
McGill Univ., Montreal (Quebec). Dept. of Meteorology.
For primary bibliographic entry see Field 2C.
W90-06012

URBAN STREAMS AS A PLACE TO LIVE (STADTBACHE ALS LEBENSRAUM).
Gesamthochschule Essen (Germany, F.R.). Inst. fuer Oekologie.
For primary bibliographic entry see Field 4C.
W90-06021

ANALYTICAL PROBLEMS ARISING FROM THE USE OF BROMIDE AND RHODAMINE WT AS CO-TRACERS IN STREAMS.
Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Coal Technology.
For primary bibliographic entry see Field 7B.
W90-06083

WATER QUALITY TRENDS OF THE UPPER OHIO RIVER FROM 1977 TO 1987.
Ohio State Univ., Columbus. School of Natural Resources.
For primary bibliographic entry see Field 5B.
W90-06102

FISHES OF THE OHIO RIVER.
Louisville Univ., KY. Water Resources Lab.
For primary bibliographic entry see Field 5G.
W90-06106

CHANGES IN FRESHWATER MUSSEL POPULATIONS OF THE OHIO RIVER: 1,000 BP TO RECENT TIMES.
Marshall Univ., Huntington, WV. Dept. of Biological Sciences.
For primary bibliographic entry see Field 6G.
W90-06107

BIRDS IN THE OHIO RIVER VALLEY: POSSIBLE INDICATORS OF ENVIRONMENTAL QUALITY.
Shawnee State Univ., Portsmouth, OH. Div. of Math/Science.
For primary bibliographic entry see Field 2H.
W90-06108

WOOD DYNAMICS IN COASTAL PLAIN BLACKWATER STREAMS.
Alabama Univ., University. Aquatic Biology Program.
For primary bibliographic entry see Field 2H.
W90-06115

RECYCLING OF ELEMENTS TRANSPORTED UPSTREAM BY RUNS OF PACIFIC SALMON: I. DELTA 15 N AND DELTA 13 C EVIDENCE IN SASHIN CREEK, SOUTHEASTERN ALASKA.
Alaska Univ., Fairbanks. School of Fisheries and Ocean Sciences.
For primary bibliographic entry see Field 2H.
W90-06119

ENVIRONMENTAL CHARACTERISTICS OF AFFLUENTS OF THE DOBCZYCE RESERVOIR (SOUTHERN POLAND) IN THE PREIMPOUNDMENT PERIOD (1983-1985): 2. PERIPHYTON.
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
For primary bibliographic entry see Field 2H.
W90-06136

ENVIRONMENTAL CHARACTERISTICS OF AFFLUENTS OF THE DOBCZYCE RESERVOIR (SOUTHERN POLAND) IN THE PREIMPOUNDMENT PERIOD (1983-1985): 3. ICHTHYOFAUNA.
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
For primary bibliographic entry see Field 2H.
W90-06137

CILIATA COMMUNITIES IN THE MIDDLE SECTOR OF THE RIVER LYNA (NORTHEASTERN POLAND) IN CONDITIONS OF NONPOINT POLLUTION INFLOW.
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Water and Wastewater Biology.
For primary bibliographic entry see Field 5C.
W90-06139

ECOLOGICAL STUDIES ON ROTIFERA (ASCHELMINTHES) IN THE RIVER TIGRIS (IRAQ).
Biological Research Center, Baghdad (Iraq). Section of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W90-06140

SALINITY AND TEMPERATURE INFLUENCE IN ROTIFER LIFE HISTORY CHARACTERISTICS.
Valencia Univ. (Spain). Dept. of Ecology.
For primary bibliographic entry see Field 2H.
W90-06143

ABUNDANCE AND DIVERSITY OF PLANKTONIC ROTIFERS IN THE PO RIVER.
Ferrara Univ. (Italy). Ist. di Zoologia.
For primary bibliographic entry see Field 2H.
W90-06150

ROTIFER DISTRIBUTION IN RELATION TO TEMPERATURE AND OXYGEN CONTENT.
Goethegasse 4, A-2380 Perchtoldsdorf, Austria.
For primary bibliographic entry see Field 2H.
W90-06151

SPECIAL FLOOD HAZARD EVALUATION REPORT. PLEASANT CREEK: VILLAGE OF EVANS MILL, JEFFERSON COUNTY, NEW YORK.

Army Engineer District, Buffalo, NY.
For primary bibliographic entry see Field 6F.
W90-06172

ROANOKE RIVER WATER FLOW COMMITTEE REPORT. A RECOMMENDED WATER FLOW REGIME FOR THE ROANOKE RIVER, NORTH CAROLINA, TO BENEFIT ANADROMOUS STRIPED BASS AND OTHER BELOW-DAM RESOURCES AND USERS.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 4A.
W90-06185

RECONNAISSANCE HYDROGEOLOGIC INVESTIGATION OF THE DEFENSE WASTE PROCESSING FACILITY AND VICINITY, SAVANNAH RIVER PLANT, SOUTH CAROLINA.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06245

STREAMFLOW, SPECIFIC-CONDUCTANCE, AND TEMPERATURE DATA FOR BAYOU AND LITTLE BAYOU CREEKS NEAR PADUCAH, KENTUCKY, AUGUST 15 AND 16, 1989.
Geological Survey, Reston, VA. Water Resources Div.
R. D. Evaldi, and D. L. McClain.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-582, 1990. 19p, 11 fig, 2 tab, 4 ref.

Descriptors: *Kentucky, *Streamflow, *Surface water, *Water quality, *Water temperature, Paducah, Stream discharge.

Discharge, temperature, and specific conductance measurements were made August 15 and 16, 1989, at 74 main channel sites and seven flowing tributaries on Bayou and Little Bayou Creeks, Kentucky in the vicinity of the Paducah Gaseous Diffusion Plant. These measurements were made during base flow conditions to provide data for analysis of the interaction of surface and groundwater. The discharge of Bayou Creek was 0.30 cfs at the most upstream site, and 5.8 cfs at the most downstream site. Total measured tributary inflow of Bayou Creek was 5.7 cfs. Specific conductance values in the Bayou Creek watershed ranged from 208 to 489 microsiemens/cm, and water temperature ranged from 20.0 to 32.6 C. The discharge of Little Bayou Creek was 0.65 cfs at the most upstream site, and 1.8 cfs at the most downstream site. Total measured tributary inflow of Little Bayou Creek was 0.38 cfs. Specific conductance values in the Little Bayou Creek watershed ranged from 211 to 272 microsiemens/cm, and water temperature ranged from 14.5 to 24.9 C. (USGS)
W90-06247

SALINITY AND FLOW RELATIONS AND EFFECTS OF REDUCED FLOW IN THE CHASSAHOWITZKA RIVER AND HOMOSASSA RIVER ESTUARIES, SOUTHWEST FLORIDA.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 2L.
W90-06249

WATER RESOURCES DATA FOR OREGON WATER, YEAR 1988, VOLUME 2. WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06250

WATER RESOURCES DATA COLLECTED DURING WATER YEAR 1988 AT SELECTED JAMES RIVER BASIN SITES IN NORTH DAKOTA AND SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06256

WATER RESOURCES DATA FOR VIRGINIA WATER YEAR 1985.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06261

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1982. VOLUME 1. WESTERN WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06262

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1982. VOLUME 2. EASTERN WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06263

WATER RESOURCES DATA FOR WASHINGTON WATER YEAR 1983.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06264

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1984.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06265

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1984.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06266

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1984.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06267

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1985.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06268

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1986.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06269

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1987.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06270

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1988.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06271

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1985.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06272

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1986.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06273

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1987.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06274

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1988.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06275

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1984.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06276

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1985.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06277

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1986.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06278

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1987.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06279

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1986.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06280

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1987.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06281

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1988.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06282

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.

Group 2E—Streamflow and Runoff

W90-06283

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06284

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06285

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06286

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 4. NORTHERN CALIFORNIA VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06287

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06289

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06290

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06291

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06292

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06294

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06295

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06296

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06297

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06299

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06300

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06301

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06302

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1986. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06304

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1986. VOLUME 2. COLORADO RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06305

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1987. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06306

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1987. VOLUME 2. COLORADO RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06307

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1988. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06308

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1985.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06309

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1986.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06310

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1987.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06311

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1988.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06312

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1982. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06313

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1982. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06314

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06315

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06316

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06317

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 1A. NORTH-EAST FLORIDA - SURFACE WATER.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06318

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 1B. NORTH-EAST FLORIDA - GROUND WATER.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06319

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06320

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06321

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 3A. SOUTH-WEST FLORIDA-SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06322

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 3B. SOUTH-WEST FLORIDA-GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06323

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06324

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 1A. NORTH-EAST FLORIDA - SURFACE WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06325

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 1B. NORTH-EAST FLORIDA - GROUND WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06326

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06327

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06328

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 3A. SOUTH-WEST FLORIDA-SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06329

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 3B. SOUTH-WEST FLORIDA-GROUND WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06330

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06331

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 1A. NORTH-EAST FLORIDA - SURFACE WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06332

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 1B. NORTH-EAST FLORIDA - GROUND WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06333

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06334

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06335

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 3A. SOUTH-WEST FLORIDA - SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06336

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 3B. SOUTH-WEST FLORIDA - GROUND WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06337

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06338

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1985.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06339

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1986.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06340

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1987.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06341

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1988.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06342

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1985. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06343

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1986. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06344

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1986. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06345

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1987. VOLUME 1, HAWAII.

Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06346

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1987. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06347

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1985.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06348

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1986.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06349

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1987.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06350

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1988.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06351

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1986. VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06352

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1986 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06353

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1987 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06354

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1987 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06355

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1988 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06356

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1988 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06357

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1985.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06358

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1986.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06359

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1987.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06360

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1988.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06361

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1986.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06362

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1987.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06363

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1988.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06364

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984 VOLUME 1B: NORTHEAST FLORIDA - GROUNDWATER.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06365

WATER RESOURCES DATA FLORIDA, WATER YEAR 1984, VOLUME 2A: SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06366

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984, VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06367

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 3B: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06368

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1984, VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06369

WATER RESOURCES DATA - FLORIDA, WATER YEAR 1985, VOLUME 1A: NORTHEAST FLORIDA-SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06370

WATER RESOURCES DATA - FLORIDA, WATER YEAR 1985, VOLUME 1B: NORTHEAST FLORIDA - GROUNDWATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06371

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06372

WATER RESOURCES DATA FOR FLORIDA WATER YEAR 1985. VOLUME 3B: SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06373

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1985 VOLUME 4: NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06374

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1984.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06375

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1984. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06376

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1984. VOLUME 2. GUAM, NORTHERN MARIANA ISLANDS, FEDERATED STATES OF MICRONESIA, PALAU, AND AMERICAN SAMOA.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06377

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1985. VOLUME 1: HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06378

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1984.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06379

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1984 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06380

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1984 VOLUME 2. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06381

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1985. VOLUME 1: ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06382

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1985 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06383

WATER RESOURCES DATA FOR INDIANA. WATER YEAR 1984.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06384

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1984.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06385

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1984.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06386

WATER RESOURCES DATA FOR KANSAS WATER YEAR 1985.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06387

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1984.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06388

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1986.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06389

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1988.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06390

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1986.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06391

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1987.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06392

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1988.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06393

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1986.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06394

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1987.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06395

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1988.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06396

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1985.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06397

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1986.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06398

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1987.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06399

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1988.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06400

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1986.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06401

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1987.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06402

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1988.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06403

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1985.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06404

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1986.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06405

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1986.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06406

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1987.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06407

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1988.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06408

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1984. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06409

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1985. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06410

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1985. VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.

Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06411

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1986. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06412

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1986. VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06413

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1985.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06414

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1986.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06415

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1987.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06416

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1988.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06417

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1986.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06418

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1987.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06419

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1988.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06420

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1986. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06421

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1986. VOLUME 2. COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06422

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1987. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06423

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1987. VOLUME 2. COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06424

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1988.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06425

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1985.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06426

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1986.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06427

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1987.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06428

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1988.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06429

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1985.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06430

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1986.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06431

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1987.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06432

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1985.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06433

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1986.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06434

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1987.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06435

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1986. VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06436

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1986. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06437

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1987. VOLUME 1: ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06438

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1987. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06439

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1988, VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06440

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1988. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06441

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1986.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06442

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1987.

Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06443

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1988.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06444

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06445

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985, VOLUME 2. LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06446

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06447

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06448

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 2: LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06449

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06450

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06451

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 2: LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06452

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06453

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06454

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 2. LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06455

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 3. WESTERN NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06456

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1985.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06457

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1984.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06458

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1985.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06459

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1984. VOLUME 1. OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06460

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1984. VOLUME 2. ST. LAWRENCE RIVER BASIN, STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06461

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1985. VOLUME 1. OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06462

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1985. VOLUME 2. ST. LAWRENCE RIVER BASIN, STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06463

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1983.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06464

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1984.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06465

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1984. VOLUME 1. EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06466

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1984. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06467

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06468

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06469

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1984.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06470

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1985.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06471

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1984.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06472

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1984. VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06473

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1984. VOLUME 2. SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.

Group 2E—Streamflow and Runoff

W90-06474

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1984. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06475

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1984.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06476

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1985.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06477

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1984.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06478

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1986.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06479

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1987.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06480

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1988.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06481

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1986.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06482

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1987.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06483

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1988.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06484

WATER RESOURCES DATA FOR OHIO, 1986. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06485

WATER RESOURCES DATA FOR OHIO, 1986. VOLUME 2: ST. LAWRENCE RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06486

WATER RESOURCES DATA FOR OHIO, 1987. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06487

WATER RESOURCES DATA FOR OHIO, 1987. VOLUME 2: ST. LAWRENCE RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06488

WATER RESOURCES DATA FOR OHIO, 1988. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06489

WATER RESOURCES DATA FOR OHIO, 1988. VOLUME 2: ST. LAWRENCE RIVER BASIN AND STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06490

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1985.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06491

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1986.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06492

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1982. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06493

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1982. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06494

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1985. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06495

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1985. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06496

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1986. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06497

WATER RESOURCES DATA FOR OREGON WATER YEAR 1986, VOLUME 2. WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06498

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06499

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06500

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06501

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06502

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06503

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06504

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06505

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1987. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06506

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1987. VOLUME 3, OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06507

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06508

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06509

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06510

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1985.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06511

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1986.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06512

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1987.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06513

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1988.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06514

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1985.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06515

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1986.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06516

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1987.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06517

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1986.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06518

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1987.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06519

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1988.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06520

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1986.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06521

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1987.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06522

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1988.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06523

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1985. VOLUME 1; ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Houston, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06524

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1985. VOLUME 2; SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06525

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1985. VOLUME 3; COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06526

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1986. VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06527

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1986. VOLUME 2: SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06528

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1986. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06529

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1987. VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06530

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1987. VOLUME 2: SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06531

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1987. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06532

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1988: VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06533

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1988. VOLUME 2: SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06534

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1988. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.

For primary bibliographic entry see Field 7C.
W90-06535

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1986.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06536

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1987.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06537

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1988.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06538

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1986.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06539

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1987.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06540

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1988.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06541

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1984.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06542

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1986.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06543

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1985.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06544

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1986.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06545

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1987.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06546

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1986.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06547

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1987.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06548

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1988.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06549

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1985.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06550

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1986.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06551

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1987.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06552

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1988.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06553

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1985.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06554

2F. Groundwater

REGIONAL GEOHYDROLOGIC-GEOMORPHIC RELATIONSHIPS FOR THE ESTIMATION OF LOW-FLOWS.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05651

STUDIES OF GEOLOGY AND HYDROLOGY IN THE BASIN AND RANGE PROVINCE, SOUTHWESTERN UNITED STATES, FOR ISOLATION OF HIGH-LEVEL RADIOACTIVE WASTE--CHARACTERIZATION OF THE RIO GRANDE REGION, NEW MEXICO AND TEXAS.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Professional Paper 1370-C, 1989. 42p. Edited by M. S. Bedinger, K. A. Sargent, and William H. Langer.

Descriptors: *Geohydrology, *Rio Grande Basin, *Groundwater movement, *Groundwater recharge, *Radioactive waste disposal, *New Mexico, *Texas, Dissolved solids.

The Rio Grande region, New Mexico and Texas, includes most of the area east of the Rio Grande to the Sacramento Mountains. Sedimentary rocks that crop out in the Rio Grande region range in age from Precambrian to Holocene. Media considered to have potential for isolation of high-level radioactive waste include intrusive rocks, ash-flow tuff, and basaltic lava flows. Laharic and mudflow breccia and argillaceous beds also may be potential host rocks. These and other rocks may be potential media in areas where the unsaturated zone is thick. Recharge to groundwater in the Rio Grande region occurs in the higher altitudes where precipitation is greater, that is, in the San Andres and Sacramento Mountains and on the Chupadera Mesa. Groundwater flows from units west of the San Andres Mountains discharge to the Rio Grande. The groundwater flow unit of the Tularosa basin ultimately discharges to the Rio Grande or to wells in the vicinity of El Paso. Intermediate discharge points in the Tularosa basin include seepage to streams and springs and evaporation to playas in the central part of the basin. Dissolved solids concentrations in groundwater in the region generally are > 1,000 mg/L, although the dissolved solids concentrations in groundwater in the recharge areas generally are < 1,000 mg/L. Dissolved solids concentrations ranging from 3,000 to 25,000 mg/L are found in the groundwater underlying the playa area in the central part of the Tularosa basin. (See also W90-05733) (Lantz-PTT)
W90-05732

GROUND-WATER HYDROLOGY.
Geological Survey, Denver, CO.
M. S. Bedinger, W. H. Langer, and J. E. Reed.
IN: Studies of Geology and Hydrology in the Basin and Range Province, Southwestern United States, for the Isolation of High-Level Radioactive Waste--Characterization of the Rio Grande Region, New Mexico and Texas. USGS Professional Paper 1370-C, 1989. p C27-C34, 1 fig, 2 tab, 16 ref.

Descriptors: *Water quality, *Water chemistry, *Rio Grande Basin, *Groundwater quality, *Geohydrology, *Groundwater movement, *New Mexico, *Texas, Flow velocity, Dissolved solids, Sulfates, Chlorides, Sodium bicarbonate.

The relative velocity of groundwater in the geohydrologic units of the Rio Grande region is between 60 m/day for the basin fill, to 9 times 10 to the -9th power m/day for fine-grained clastic rocks. The quality of water in the Rio Grande region is characterized by maps showing the areal distribution of dissolved solids and predominant chemical constituents in solution. The dissolved solids concentration generally is > 1,000 mg/L throughout the region. Groundwater containing dissolved solids concentrations of> 3,000 mg/L to as much as 25,000 mg/L is found in the northern and central part of the Tularosa Valley in New Mexico, and along the Rio Grande in Texas. Sulfate-type water is the most common, occurring in about 68% of the region. Chloride-type water is common in New Mexico, near the Rio Grande in Texas, and in a large area of the north-central Texas part of the region. Chloride-type water occurs in about 15% of the region, generally in areas corresponding to the areas where dissolved solids are greatest. Sodium-bicarbonate-type water, which occurs in about 10% of the region, is in scattered areas along the western and southern borders of the region. Calcium-magnesium bicarbonate-type water, which occurs in about 10% of the region, is primarily in scattered areas in the San Andres, Organ, and Sacramento Mountains. (See also W90-05732) (Lantz-PTT)
W90-05733

FLOW OF GROUND WATER THROUGH FRACTURED CARBONATE ROCKS IN THE PRAIRIE DU CHIEN-JORDAN AQUIFER, SOUTHEASTERN MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-05738

NATIONAL RESEARCH PROGRAM OF THE WATER RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY, FISCAL YEAR 1988.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 9D.
W90-05744

GROUNDWATER LEVELS PORTALES AREA, NEW MEXICO, 1982-1987.
For primary bibliographic entry see Field 7C.
W90-05745

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--OZARK AQUIFER.
For primary bibliographic entry see Field 7C.
W90-05746

GROUND-WATER-QUALITY ASSESSMENT OF THE CENTRAL OKLAHOMA AQUIFER, OKLAHOMA--ANALYSIS OF AVAILABLE WATER-QUALITY DATA THROUGH 1987.
For primary bibliographic entry see Field 5B.
W90-05749

HANFORD SITE GROUND-WATER MONITORING DATA LISTING, JANUARY 1 THROUGH MARCH 31, 1987.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W90-05752

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 4--APPENDIX A.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 8A.
W90-05766

CYCLIC METAL MIGRATION IN A GROUNDWATER STREAM.
Paul Scherrer Inst., Wuerenlingen (Switzerland).
For primary bibliographic entry see Field 5B.
W90-05767

DETECTION OF SUBSURFACE FLOW PHENOMENA BY SELF-POTENTIAL/GEOELECTRICAL AND THERMICAL METHODS.
For primary bibliographic entry see Field 7B.
W90-05771

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 6 -- APPENDIX B (CONTD).
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W90-05785

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 9 -- APPENDIX C.
Battelle Pacific Northwest Labs., Richland, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-000263. Price codes: A06 in paper copy, A01 in microfiche. Report No. PNL--6581-Vol.9, May 1988. 187 p. DOE Contract DE-AC06-76RLO-1830.

Descriptors: *Data collections, *Groundwater management, *Groundwater quality, *Hanford Site, *Monitoring, *Radioactive wastes, *Washington, *Wells, Inspection, Well construction, Well logs.

This appendix is one of nine volumes, and presents data describing wells completed at the Hanford Site, Washington, during the first quarter of the calendar year 1988 (January through March). The data in this volume of Appendix B cover the following wells: 199-N-58, 199-N-59, 199-N-60, 199-N-61, and 199-N-67. The data are presented in the following order: well completion report/Title III inspection list, as-built diagram, logging charts, and drill logs. (See also W90-05785) (Lantz-PTT)
W90-05786

EVALUATION OF NATURAL RECHARGE TO AQUIFERS IN THE SUDAN-SAHEL CLIMATE USING GLOBAL HYDROLOGICAL MODELLING: APPLICATION TO TEN SITES IN BURKINA FASO (EVALUATION DE LA RECHARGE NATURELLE DES AQUIFERES EN CLIMAT SOUDANO-SAHELIEN PAR MODELISATION HYDROLOGIQUE GLOBAL: APPLICATION A DIX SITES AU BURKINA FASO).
Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept.
C. Filippi, F. Milville, and D. Thiery.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 1, p 29-48, February 1990. 7 fig, 10 tab, 18 ref. English summary.

Descriptors: *Aquifers, *Groundwater recharge, *Hydrologic models, *Model studies, *Sahel, *Sudan, *Water yield, Evapotranspiration, Piezometers, Rainfall, Recharge, Simulation analysis, Streamflow.

The considerable effort made to exploit groundwater in the Sudan-Sahel region made the evaluation of the natural aquifer flow due to rainfall necessary. Research by an international group of organizations was performed at ten sites within three regions of Burkina-Faso. Each site was equipped with a climate station and a continuous groundwater-level recorder during 1985 and 1986 in order to make pumping tests. The piezometric measurements at each site have been separately analyzed using lumped hydrological models simulating the processes of rainfall, evapotranspiration, streamflow and recharge. The operation of the models showed that, in the absence of surface flow measurements, it is not possible to resolve completely the difficulties of estimating the storage coefficient of aquifers. An analysis of surface flow measurements in neighboring basins associated via a hypothesis of model parameter homogeneity within a given region has allowed a conclusion to be reached which constitutes the best possible compromise between all the data. A simulation of piezometric levels and recharge in the period 1954-1986, from available piezometric abstracts at four synoptic stations, allowed the evaluation of the variability of recharge and a statistical assessment of the 1985-1986 period of observation. The calculated annual recharge varies from year to year in the ratio of one to two or one to three according to the site. The simulation indicated that the recharge calculated for 1985 is near the minimum of the period 1954-1986 in the regions of Katchari, Silmissin and Barogo, and near the mean in the region of Sideradougou. (Author's abstract)
W90-05837

3-D FINITE ELEMENT TRANSPORT MODELS BY UPWIND PRECONDITIONED CONJUGATE GRADIENTS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
For primary bibliographic entry see Field 5B.
W90-05882

SIMULATION OF REGIONAL SUBSURFACE FLOW BY FINITE ELEMENT MODELS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
For primary bibliographic entry see Field 2F.
W90-05883

SIMULATION OF REGIONAL SUBSURFACE FLOW BY FINITE ELEMENT MODELS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
G. Gambolati, G. Pini, and G. Verri.
Advances in Water Resources AWREDI, Vol. 12, No. 2, p 59-65, June 1989. 8 fig, 1 tab, 8 ref.

Descriptors: *Finite element method, *Groundwater movement, *Mathematical models, *Regional analysis, *Simulation analysis, Computer models, Dupuit-forchheimer theory, Glacial aquifers, Hydrologic budget, Numerical analysis.

Numerical models represent very useful tools for the simulation of regional flows and may provide a framework for rational management and allocation of the available water resources. The complex alluvial aquifer systems underlying the Friuli-Venezia Guilia Region in northeastern Italy have been analyzed with the aid of two combined models based on the finite element method. The first model simulates the unconfined steady flow in the coarse-grained Upper Plain aquifer and relies on the Dupuit-Forcheimer-Boussinesq approach. Calibration of the Upper Plain model was based upon piezometric data collected during the dry season. The second model simulates the multi-aquifer basin of the finer-grained Lower Plain, and is based on the integro-differential theory of flow. Both models have been run under a series of realistic assumptions based upon the limited information available. The results obtained for the dry regime are moderately satisfactory and allow for the first-hand appraisal of the quantity involved in the overall regional groundwater balance. They also point out the need for a substantial improvement in the quality and quantity of the regional subsurface data to generate future predictions in a wider framework of practical interest. (Author's abstract)
W90-05883

MODELLING OF SOME ELLIPTIC FLUID MECHANICS PROBLEMS BY THE BOUNDARY ELEMENT METHOD.
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05884

MULTI-COMPARTMENTAL MODELLING FOR AQUIFER PARAMETER ESTIMATION USING NATURAL TRACERS IN NON-STEADY FLOW.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
E. Adar, and S. Sorek.
Advances in Water Resources AWREDI, Vol. 12, No. 2, p 84-89, June 1989. 3 fig, 22 ref.

Descriptors: *Aquifer characteristics, *Environmental tracers, *Groundwater movement, *Mathematical models, *Parameter estimation, *Unsteady flow, Conductivity, Isotopic tracers, Storativity, Transmissivity, Water chemistry.

Aquifers in many basins have been heavily exploited without complete information about the hydrological characteristics of the groundwater system. Aquifer parameters can be estimated with a mathematical model if there are enough wells to provide hydraulic head measurements and water samples for chemical and isotopic analysis. A model was developed based upon a distributed parameter approach in which the aquifer is represented by a finite number of cells. Inflows through aquifer boundaries and internal fluxes are evaluated by optimizing a set of mass balance equations. The model utilizes natural tracers such as dissolved chemicals, stable isotope ratios, and electrical conductivity measurements that are relatively easy to obtain and measure. The method estimates aquifer parameters for non-steady flow regimes, such that the same head values are identified during seasonal time periods. (Tappert-PTT)
W90-05887

PREDICTION OF TRANSMISSIVITIES, HEADS, AND SEEPAGE VELOCITIES USING MATHEMATICAL MODELING AND GEOSTATISTICS.
Calvin Coll., Grand Rapids, MI. Dept. of Engineering.
R. J. Hoeksema, and P. K. Kitanidis.

Advances in Water Resources AWREDI, Vol. 12, No. 2, p 90-102, June 1989. 17 fig, 1 tab, 23 ref. USGS Grant 14-08-0001-G1491.

Descriptors: *Flow velocity, *Geostatistics, *Groundwater movement, *Mathematical models, *Seepage, *Transmissivity, *Uncertainty, Computer models, Prediction, Statistical methods, Storativity.

Groundwater models are widely used in hydrogeologic studies to predict hydraulic head, flow rates, and solute concentrations. However, in most regional studies the modeler has only a few measurements of head, the results of some pumping tests, and a vague idea of the boundary conditions, leakage, or rates of recharge. As a result, elaborate models are calibrated on the basis of scant information, and double accounting or recycling of information is common. Statistical methods, which recognize sources of uncertainty and their propagation through the flow equations, provide a practical system of information accounting that distinguishes between what is really given from what is indirectly inferred. Geostatistical methodology is used to calculate the best estimates of four spatially distributed variables associated with a two-dimensional model for steady-state flow in a confined aquifer. The variables are the logarithm of the transmissivity, hydraulic head, x-direction seepage velocity, and the y-direction seepage velocity. The methodology relies upon estimating values for the variables, computing a cokriging variance to provide some measure of the confidence that can be placed in the values, and performing conditional simulations that allow the modeler to investigate the full range of model uncertainty or variability given the available data. Using conditional simulations, the modeler can generate many possible (e.g., equally probable) log-transmissivity, head, and velocity functions that conform to the available data. Application of the approach to a hypothetical aquifer system demonstrates that the method allows the modeler to obtain a better picture of the accuracy of model predictions. (Tappert-PTT)
W90-05888

GROUNDWATER RECHARGE IN URBAN AREAS.
Birmingham Univ. (England). School of Earth Sciences.
For primary bibliographic entry see Field 4C.
W90-05899

SURVEY FOR PESTICIDES IN WELLS ASSOCIATED WITH APPLE AND PEACH ORCHARDS IN WEST VIRGINIA.
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5B.
W90-06035

SR87/SR86 VALUES OF CANADIAN SHIELD BRINES AND FRACTURE MINERALS WITH APPLICATIONS TO GROUNDWATER MIXING, FRACTURE HISTORY, AND GEOCHRONOLOGY.
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
R. H. McNutt, S. K. Frape, P. Fritz, M. G. Jones, and I. M. MacDonald.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 1, p 205-215, January 1990. 5 fig, 4 tab, 46 ref, append.

Descriptors: *Canadian Shield, *Geochemistry, *Geological data, *Isotope studies, *Isotopic tracers, *Minerals, *Strontium, Brines, Calcite, Canada, Geologic fractures, Geologic history, Groundwater movement, Ion exchange, Mineral water, Saline groundwater, Stable isotopes.

Analyses of saline waters, fracture minerals, and host rocks from seven localities on the Canadian Shield demonstrate the utility of the Sr87/Sr86 (strontium) ratio in the study of groundwater systems in crystalline rocks. The ratios range from 0.704 to 0.753 and have obtained their signatures by mineral/rock interactions, primarily involving the feldspars. Brines have been identified from isolated pockets in the same mines where extensive flow regimes exist. There is mixing of different brines as well as mixing with meteoric waters. The isotopic results on calcites from fractures and shear zones show more than one generation of mineral growth in a given fracture. The Sr87/Sr86 ratios of the calcites vary from values identical to the present-day brine in the fracture zone to ratios with Archean signatures. This implies that activity may occur in fault zones over a very long time. The brines are very rich in Sr (up to 2400 mg/L), very low in Rb, and have relatively radiogenic Sr87/Sr86 ratios. They are ubiquitous in Shield rocks and, if they were present throughout geological time, they may be one reason why Rb/Sr (rubidium/strontium) ages of felsic plutons are commonly younger than associated U/Pb (uranium/lead) ages. (Author's abstract)
W90-06058

BRINES EXPELLED ALONG THE MAIN THRUSTS OF THE WESTERN ALPS (MIGRATION DES SAUMURES AU FRONT DES CHEVAUCHEMENTS DE L'ARC ALPIN OCCIDENTAL).
Montpellier-2 Univ. (France). Lab. de Geologie Structurale Appliquee.
For primary bibliographic entry see Field 2K.
W90-06063

STUDIES OF GEOLOGY AND HYDROLOGY IN THE BASIN AND RANGE PROVINCE, SOUTHWESTERN UNITED STATES, FOR ISOLATION OF HIGH-LEVEL RADIOACTIVE WASTE--CHARACTERIZATION OF THE DEATH VALLEY REGION, NEVADA AND CALIFORNIA.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Geological Survey Professional Paper 1370-F, 1989. 49p. Edited by M.S. Bedinger, K.A. Sargent, and William H. Langer.

Descriptors: *California, *Geohydrology, *Geology, *Hydrology, *Nevada, *Radioactive wastes, *Waste disposal, Carbonate rocks, Colorado River, Death Valley, Flow profiles, Groundwater movement, Spring water.

The Death Valley region, Nevada and California, in the Basin and Range province, is an area of about 80,200 sq km located in southern Nevada and southeastern California. Precambrian metamorphic and intrusive basement rocks are overlain by a thick section of Paleozoic clastic and evaporitic sedimentary rocks. Mesozoic and Cenozoic rocks include extrusive and intrusive rocks and clastic sedimentary rocks. Structural features within the Death Valley indicate a long and complex tectonic evolution from late Precambrian to the present. Potential repository host media in the region include granite and other coarse-grained plutonic rocks, ashflow tuff, basaltic and andesitic lava flows, and basin fill. The Death Valley region is composed largely of closed topographic basins that are apparently coincident with closed groundwater flow systems. In these systems, recharge occurs sparingly at higher altitudes by infiltration of precipitation or by infiltration of ephemeral runoff. Discharge occurs largely by spring flow and by evaporation and transpiration in the playas. Death Valley proper, for which the region was named, is the ultimate discharge area for a large, complex system of groundwater aquifers that occupy the northeastern part of the region. The deepest part of the system consists of carbonate aquifers that connect closed topographic basins at depth. The discharge from the system occurs in several intermediate areas that are geomorphically, stratigraphically, and structurally controlled. Ultimately, most groundwater flow terminates by discharge to Death Valley; groundwater is discharged to the Colorado River from a small part of the region. (Lantz-PTT)
W90-06160

GROUND-WATER HYDROLOGY.
Geological Survey, Denver, CO. Water Resources Div.
M. S. Bedinger, W. S. Langer, and J. E. Reed.
IN: Studies of Geology and Hydrology in the Basin and Range Province, Southwestern United States, for Isolation of High-Level Radioactive Waste--Characterization of the Death Valley Region, Nevada and California. USGS Geological Survey Professional Paper 1370-F, 1989. p F28-F35, 3 fig, 2 tab, 25 ref.

Descriptors: *Geohydrology, *Groundwater movement, Bicarbonates, Dissolved solids, Flow profiles, Groundwater quality, Groundwater recharge, Infiltration, Springs.

Climate of the Death Valley region is arid to semiarid. The annual average precipitation at Furnace Creek Ranch in DEAth Valley is 50 mm/yr. Groundwater recharge occurs by infiltration of precipitation and runoff. Recharge in basins in California and Nevada has been estimated as a function of the quantity of precipitation. Estimated recharge in areas receiving < 200 mm of precipitation annually was estimated to be < 3% of precipitation; recharge was estimated to be 3% for areas receiving 200-300 mm and 7% for areas receiving 300-380 mm. Natural discharge is by flow to springs, by evapotranspiration in areas where the water level is near the land surface, and by seepage to the Colorado River. The quality of groundwater in the Death Valley region is characterized by the areal distribution of dissolved solids and predominant chemical constituents in solution. Dissolved solids concentration is generally < 500 mg/L except beneath the surfaces of some playa lakes, where groundwater may contain > 500 mg/L of dissolved solids. Sodium bicarbonate and calcium-magnesium bicarbonate type waters occur throughout about 90% of the region. Mixed-cation sulfate and mixed-cation chloride type waters occur in and near natural discharge areas and generally correspond to areas of maximum dissolved solids concentration. (Lantz-PTT)
W90-06161

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 7--APPENDIX B (CONTD).
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W90-06178

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 5--APPENDIX B.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W90-06179

ASSESSMENT OF THE POTENTIAL FOR TRANSPORT OF DIOXINS AND CODISPOSED MATERIALS TO GROUNDWATER.
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-06182

FLOW AND TRANSPORT IN POROUS FORMATIONS.
Tel-Aviv Univ. (Israel). Dept. of Fluid Mechanics and Heat Transfer.
G. Dagan.
Springer-Verlag, New York, New York. 1989. 465 p.

Descriptors: *Groundwater movement, *Model studies, *Path of pollutants, *Porous media, *Solute transport, *Stochastic models, Flow profiles, Heterogeneity, Homogeneity, Mathematical studies.

A comprehensive textbook on water flow and solute transport in porous media summarizes recent developments in stochastic modeling of subsurface flow and transport at different scales. One of the

main topics is the analysis of the effects heterogeneous natural formations exert upon water flow and contaminant transport. Sections present material about: (1) elements of probability theory and random functions; (2) the laboratory scale (homogeneous media; (3) water flow at the local (formation) scale; (4) solute transport at the local (formation) scale; and (5) flow and transport at the regional scale. (Lantz-PTT)
W90-06188

ROLE OF SUB-SURFACE CONTAMINANT FATE AND TRANSPORT MODELS FOR RCRA LAND BAN REGULATIONS.
Kuo and Associates, McLean, VA.
For primary bibliographic entry see Field 5B.
W90-06200

IN SITU DETECTION OF ORGANIC MOLECULES.
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
For primary bibliographic entry see Field 5A.
W90-06201

HYDROGEOLOGY AND RESULTS OF AQUIFER TESTS IN THE VICINITY OF A HAZARDOUS-WASTE DISPOSAL SITE NEAR BYRON, ILLINOIS.
Geological Survey, Urbana, IL. Water Resources Div.
R. T. Kay, D. N. Olson, and B. J. Ryan.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4081, 1989. 62p, 24 fig, 8 tab, 12 ref.

Descriptors: *Aquifer characteristics, *Aquitards, *Groundwater movement, *Transmissivity, *Unconfined aquifers, Hazardous wastes, Hydraulic conductivity, Illinois, Ogle County, Specific yield, Storativity, Water disposal sites.

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency, conducted an investigation of a Superfund Site near Byron, Illinois. The purpose of the investigation was to determine the hydrogeologic properties of the Galena-Platteville and St. Peter aquifers, the primary water-supply aquifers for domestic supply in the area. The Galena and Platteville Groups and older St. Peter Sandstone are separated by the Harmony Hill Shale Member of the Glenwood Formation. The Harmony Hill Shale Member is a semiconfining unit. Groundwater flow in the study area is from the site northwestward to the Rock River. Movement of groundwater in the dolomites is mainly through joints, fractures, and solution openings. Analysis of the Galena-Platteville aquifer-test data indicates that the calculated aquifer transmissivity ranges from 490 to 670 sq ft/day, and the calculated specific yield ranges from 0.017 to 0.140. Aquifer test data also indicate that the Galena-Platteville aquifer is heterogeneous and anisotropic. Analysis of the St. Peter aquifer-test data indicates that the calculated transmissivity of the aquifer ranges from 1,200 to 1,305 sq ft/day, storativity ranges from 0.000528 to 0.00128, horizontal hydraulic conductivity ranges from 2.9 to 3.1 ft/day, and leakage through the Harmony Hill Shale Member ranges from .000123 to .000217 ft/day/ft. (USGS)
W90-06220

CONVERSION AND COMPARISON OF THE MATHEMATICAL, THREE-DIMENSIONAL, FINITE-DIMENSIONAL, GROUND-WATER FLOW MODEL TO THE MODULAR, THREE-DIMENSIONAL, FINITE-DIFFERENCE, GROUND-WATER FLOW MODEL FOR THE TESUQUE AQUIFER SYSTEM IN NORTHERN NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
A. M. J. Umari, and T. L. Szeliga.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-26, Dec 1988. 39p, 23 fig, 3 tab, 10 ref.

Descriptors: *Groundwater movement, *Mathematical models, *Model studies, *New Mexico, Geohydrology, Tesuque, Three-dimensional model, Water level.

The three-dimensional finite-difference groundwater model (using a mathematical groundwater flow code) of the Tesuque aquifer system in northern New Mexico was converted to run using the U.S. Geological Survey's modular groundwater flow code. Results from the final versions of the predevelopment and 1947 to 2080 transient simulations of the two models are compared. A correlation coefficient of 0.9905 was obtained for the match in block-by-block head-dependent fluxes for predevelopment conditions. There are, however, significant differences in at least two specific cases. In the first case, a difference is associated with the net loss from the Pojoaque River and its tributaries to the aquifer. The net loss by the river is given as 1.134 cu ft/sec using the original groundwater model, which is 38.1% less than the net loss by the river of 1.8319 cu ft/sec computed in this study. In the second case, the large difference is computed for the transient decline in the hydraulic head of a model block near Tesuque Pueblo. The hydraulic-head decline by 2080 is, using the original model, 249 ft, which is 14.7% less than the hydraulic head of 292 ft computed by this study. In general, the differences between the two sets of results are not large enough to lead to different conclusions regarding the behavior of the system at steady state or when pumped. (USGS)
W90-06222

GEOHYDROLOGY, SIMULATION OF GROUND-WATER FLOW, AND GROUND-WATER QUALITY AT TWO LANDFILLS, MARION COUNTY, INDIANA.
Geological Survey, Indianapolis, IN. Water Resources Div.
R. F. Duwelius, and T. K. Greeman.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4100, 1989. 135p, 29 fig, 23 tab, 24 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Landfills, *Model studies, *Water pollution sources, Aquifers, Computer models, Flow system, Sludge, Solid waste disposal.

Geologic, hydrologic, and water-quality data were collected at the Julietta and Tibbs-Banta landfills in Marion County. Both landfills were closed in the mid 1970's, and sewage sludge mixed with dirt was spread on the landfills in the mid 1980's as part of a revegetation project. The landfills are constructed in unconsolidated glacial sediments that consist of sand, gravel, silt, and clay. The maximum thickness of the sediments it 180 ft at Julietta and 100 ft at Tibbs-Banta. Both landfills are underlain by sand and gravel aquifers and are adjacent to gaining streams. Groundwater flows toward and into the streams at each study area. Two sand and gravel aquifers were mapped at Julietta and four were mapped at Tibbs-Banta. The aquifers are separated in places by discontinuous clay layers. Groundwater-flow models, calibrated to simulate steady-state low-flow conditions, indicate that about 19,000 gal of water/day flow through the refuse at Julietta and about 42,000 gal/day flow through the refuse at Tibbs-Banta. Concentrations of dissolved inorganic substances in groundwater samples indicate that leachate from both landfills is reaching the shallow aquifers. The effect of the leachate on deep aquifers is minimal because of the predominance of horizontal groundwater flow and discharge to the streams. Increases in almost all dissolved constituents were observed in shallow wells that are screened beneath and downgradient from the landfills. Bromide, dissolved solids, and ammonia were useful in delineating the plume of leachate at both landfills. (USGS)
W90-06223

WATER RESOURCES OF VILAS COUNTY, WISCONSIN.
Geological Survey, Madison, WI. Water Resources Div.
G. L. Patterson.
Available from WG&NHS, 3817 Mineral Point Road, Madison, WI 53705. Wisconsin Geological and Natural History Survey (WG&NHS) Miscellaneous Paper 89-1, 1989. 46p, 10 fig, 1 pl, 10 tab, 19 ref.

Descriptors: *Acid rain effects, *Geohydrology, *Groundwater, *Water quality, *Water resources data, *Wisconsin, Alkalinity, Groundwater level, Hydraulic conductivity, Vilas County.

The Pleistocene drift in Vilas County, Wisconsin, consists of three types of material: till, debris-flow sediment, and fluvial sediment. Hydraulic conductivity of the sand and gravel is on the order of 0.001 ft/sec but that of the till and debris-flow sediment is on the order of 0.0001 ft/sec. Calculations of transmissivity indicate that most sand and gravel deposits can yield sufficient quantities of potable water for domestic use, but the till and debris-flow deposits cannot. The water table is generally shallow and there is little water-level fluctuation throughout the county. Fifty-six wells had median depths to water of less than 20 ft. The range of fluctuations varied from 0.5 to 7.36 ft. Analysis of water samples collected from 50 observation wells indicate that calcium, magnesium, and bicarbonate are the major dissolved constituents. Alkalinity concentrations in Vilas County ranged from 2 to 152 mg/L and had a median concentration of 28 mg/L. The median concentration was lower than the 102 mg/L median for the surrounding area. The low alkalinity concentration in groundwater implies a limited capacity to neutralize acid; this may increase the potential for degradation of lakes by acid precipitation. Alkalinity data for surface water were used to classify 546 lakes according to their sensitivity to acid precipitation. Five lakes are classified as ultrasensitive, 108 lakes are classified as extremely sensitive, 185 lakes are classified as moderately sensitive, 89 lakes are classified as having low sensitivity, and 159 lakes are classified as not sensitive. (USGS)
W90-06224

HYDROGEOLOGY OF WOOD COUNTY, WISCONSIN.
Geological Survey, Madison, WI. Water Resources Div.
W. G. Batten.
Available from WG&NHS, 3817 Mineral Point Road, Madison, WI 53705. Wisconsin Geological and Natural History Survey (WG&NHS) Information Circular 60, 1989. 27p, 8 fig, 2 pl, 7 tab, 20 ref.

Descriptors: *Groundwater, *Water resources data, *Wisconsin, Aquifer characteristics, Aquifers, Groundwater movement, Groundwater quality, Groundwater recharge, Wood County.

The groundwater resources of Wood County, Wisconsin, are described. Groundwater is pumped only from wells drilled in Precambrian rock in the northern two-thirds of the county. The generally low permeability of this rock limits the availability of groundwater in this area. Saturated deposits of sand and gravel yield more than 500 gal/min to wells in the southern part of the county. Background groundwater quality and indicators of groundwater-quality problems, such as elevated concentrations of nitrate, chloride, hardness, and iron, are compared by aquifer for the entire county. An elevated concentration of iron is the major water quality problem in the county. Results of water quality analysis from observation wells drilled next to abandoned landfills throughout the county indicate that groundwater in the immediate vicinity of these landfills has been affected by leachate. The report includes maps of the thickness and saturated thickness of unconsolidated deposits, a water-table map, and tables of aquifer-production and well-production data from about 1,500 drillers' well-construction reports. (USGS)
W90-06225

HYDROGEOLOGIC CHARACTERISTICS OF THE LEE ACRES LANDFILL AREA, SAN JUAN COUNTY, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.

K. D. Peter, R. A. Williams, and K. W. King.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4246, 1987. 69p, 17 fig, 7 tab, 16 ref.

Descriptors: *Alluvial aquifers, *Groundwater movement, *Groundwater pollution, *Landfills, *Lee Acres Landfill, *New Mexico, *Path of pollutants, *Water pollution sources, Geohydrology, Hydraulic properties, Piezometers, Water table gradient.

Identification of the presence of volatile organic compounds in liquid-waste lagoons in New Mexico at the Lee Acres landfill, beneath a refinery south of the landfill, and in nearby residential wells has led to an hydrologic investigation of the area. The alluvium underlying an arroyo adjacent to the landfill mostly consists of fine to coarse quartz sand with some silt, gravel, and clay zones. Thickness of the alluvium measured in 12 drill holes ranged from 13.7 to 61.5 ft. A seismic survey indicates that buried channels are incised as much as 26 ft into the bedrock surface in some areas. The depth to water in seven piezometers ranged from 26.6 to 34.9 ft. The configuration of the water table in the alluvium indicates that groundwater flow is controlled by unidentified recharge north of the landfill, recharge from a pond southeast of the landfill, discharge to pumping wells, discharge to the alluvium of the San Juan River south of the study area, and hydraulic conductivity of the alluvial material. There also may be additional recharge to or discharge from the underlying Nacimiento Formation and recharge from runoff in the arroyo. Terrain-conductivity measurements indicate that the water in the alluvium southwest of the landfill may be more conductive than water in the underlying sandstone. (USGS)
W90-06228

SIMULATION OF THE REGIONAL GEOHYDROLOGY OF THE TESUQUE AQUIFER SYSTEM.
Geological Survey, Albuquerque, NM. Water Resources Div.
D. P. McAda, and M. Wasiolek.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4056, 1987. 71p, 24 fig, 12 tab, 44 ref.

Descriptors: *Geohydrology, *Model studies, *New Mexico, *Unconsolidated aquifers, Computer models, Tesuque Aquifer System.

Declining groundwater levels resulting from groundwater withdrawals in the Santa Fe, New Mexico, area have caused concern about the future availability of water in the Tesuque aquifer system. This report describes the geohydrology of the Tesuque aquifer system in the Santa Fe area and presents a three-dimensional regional groundwater flow model which assesses the effects of existing and possible future groundwater withdrawals on the regional aquifer system. The model was calibrated using simulations of the predevelopment steady-state condition and the 1947-82 historical period. The response of the aquifer to two scenarios of future groundwater withdrawals from 1983 to 2020 was simulated. (USGS)
W90-06229

VARIABLE-DENSITY GROUND-WATER FLOW AND PALEOHYDROLOGY IN THE WASTE ISOLATION PILOT PLANT (WIPP) REGION, SOUTHEASTERN NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-06230

RECONNAISSANCE HYDROGEOLOGIC INVESTIGATION OF THE DEFENSE WASTE PROCESSING FACILITY AND VICINITY, SAVANNAH RIVER PLANT, SOUTH CAROLINA.
Geological Survey, Columbia, SC. Water Resources Div.
K. F. Dennehy, D. C. Prowell, and P. B. McMahon.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4221, 1989. 74p, 27 fig, 8 tab, 72 ref.

Descriptors: *Geohydrology, *Geology, *Path of pollutants, *Radioactive waste disposal, *Solute transport, *South Carolina, *Surface water, *Underground waste disposal, Aiken County, Barnwell County, Waste disposal, Water quality.

The hydrogeologic framework of the area around the Savannah River Plant, South Carolina consists of 2 to 3 separate water bearing units. In the northern half of the study area, the Barnwell and underlying McBean aquifers are considered one aquifer owing to the absence of the tan clay-confining unit between them. In the southern half of the study area they are separated by the tan clay into two aquifers. Underlying these aquifers, and separated from them by the green clay-confining unit, is the Congaree aquifer. Hydraulic conductivities of the aquifers range from 0.00000001 to 0.0001 ft/sec. Directions of groundwater flow in the Barnwell and McBean aquifers are to the north, with a component of flow directed downward across the green clay and into the Congaree aquifer. The direction of flow in the Congaree aquifer is to the northwest. Water in these aquifers evolves from an acidic ($pH < 6.5$) mixed-cation type in the Barnwell aquifer to an alkaline ($pH > 8$) calcium bicarbonate water in the Congaree aquifer. Laboratory experiments indicate that reactions between sediments of the Barnwell aquifer and a salt-solution waste to be stored at the study area would significantly reduce the permeability of the sediment, thereby limiting the movement of the waste in groundwater at the site. (USGS)
W90-06245

LITHOLOGY, THICKNESS, AND EXTENT OF HYDROGEOLOGIC UNITS UNDERLYING THE EAST PORTLAND AREA, OREGON.
Geological Survey, Portland, OR. Water Resources Div.
S. V. Hartford, and W. D. McFarland.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4110, 1989. 23p, 5 fig, 6 plates (maps), 1 tab, 46 ref.

Descriptors: *Aquifers, *Geohydrology, *Geology, *Groundwater, *Oregon, Maps.

The lithology, thickness, and extent of eight distinct hydrogeologic units are described and mapped within the East Portland area of Oregon. The thickness, extent, and top of each unit are shown on contour maps at scales of 1:24,000. Their stratigraphic relations are displayed on a diagrammatic cross section. The geologic setting and unit lithology are described within the text. A data table presents information on each well or boring that was used for determining the thickness, extent, and lithology of each hydrogeologic unit. The hydrogeologic units range in age from late Miocene to Holocene and include several facies of the Troutdale Formation and Sandy River Mudstone, as well as Quaternary deposits of the Columbia River. From oldest to youngest, these units are referred to as: the sand and gravel aquifer, confining layer 2, Troutdale sandstone aquifer, confining layer 1, Unconsolidated gravel/Troutdale gravel aquifer, Columbia River sand aquifer, Blue Lake gravel aquifer, and overbank deposits. The total thickness of these sedimentary deposits is more than 1,300 ft in the sandy area. (USGS)
W90-06248

GEOHYDROLOGY OF THE REGIONAL AQUIFER SYSTEM, WESTERN SNAKE RIVER PLAIN, SOUTHWESTERN IDAHO.
Geological Survey, Boise, ID. Water Resources Div.
G. D. Newton.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-317, 1989. 82p, 33 fig, 1 plate, 12 tab.

Descriptors: *Computer models, *Computer programs, *Finite difference methods, *Geohydrology, *Groundwater level, *Groundwater movement, *Idaho, *Model studies, Aquifer characteristics, Boise River Valley, Groundwater budget, Groundwater pumping, Groundwater recharge, Model calibration, Simulation, Well hydrographs, Western Snake River Plain.

A three dimensional groundwater flow model was developed to simulate steady state and nonsteady-state hydrologic conditions of the regional aquifer system in the western Snake River Plain of Idaho. Water budget analysis showed that groundwater recharge was about 1,400,000 acre-ft in 1980; groundwater pumpage was estimated to be 300,000 acre-ft. Two mass water level measurements were made in March and August 1980 to define the water table in the regional system. The model was discretized into 25 rows, 72 columns, and 3 layers. Each cell represented 4 sq mi. The model was calibrated to 1980 hydrologic conditions. Calibrated transmissivity of layer 1 (500 ft thick) ranged from 1,500 to 21,500 sq ft/day. Calibrated specific yield of unconfined aquifers was 0.10 and calibrated storage coefficient of confined aquifers ranged from 0.0004 to 0.007. The calibrated model was verified by simulating monthly water-level fluctuations for 1980. Simulated water levels matched measured levels in the Boise River Valley, but the match in other areas was poor. (USGS)
W90-06257

WATER RESOURCES DATA FOR VIRGINIA WATER YEAR 1985.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06261

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1982. VOLUME 1. WESTERN WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06262

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1982. VOLUME 2. EASTERN WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06263

WATER RESOURCES DATA FOR WASHINGTON WATER YEAR 1983.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06264

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1984.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06265

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1984.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06266

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1984.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06267

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1985.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06268

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1986.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06269

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1987.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06270

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1988.
Geological Survey of Alabama, University. Div. of Water Resources.
For primary bibliographic entry see Field 7C.
W90-06271

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1985.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06272

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1986.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06273

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1987.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06274

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1988.
Geological Survey, Anchorage, AK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06275

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1984.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06276

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1985.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06277

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1986.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06278

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1987.
Geological Survey, Tucson, AZ.
For primary bibliographic entry see Field 7C.
W90-06279

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1986.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06280

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1987.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06281

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1988.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06282

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06283

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 4. NORTHERN CALIFORNIA VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06287

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06288

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06293

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06297

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06298

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06303

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1986. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06304

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1986. VOLUME 2. COLORADO RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06305

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1987. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06306

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1987. VOLUME 2. COLORADO RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06307

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1988. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06308

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1985.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06309

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1986.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06310

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1987.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06311

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1988.
Geological Survey, Hartford, CT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06312

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1982. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06313

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1982. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.

For primary bibliographic entry see Field 7C.
W90-06314

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06315

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06316

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06317

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 1A. NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06318

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 1B. NORTHEAST FLORIDA - GROUND WATER.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06319

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06320

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06321

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 3A. SOUTHWEST FLORIDA-SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06322

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 3B. SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06323

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06324

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 1A. NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06325

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 1B. NORTHEAST FLORIDA - GROUND WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06326

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06327

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06328

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 3A. SOUTHWEST FLORIDA-SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06329

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 3B. SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06330

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06331

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 1A. NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06332

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 1B. NORTHEAST FLORIDA - GROUND WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06333

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06334

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06335

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 3A. SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06336

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 3B. SOUTHWEST FLORIDA - GROUND WATER.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06337

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06338

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1985.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06339

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1986.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06340

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1987.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06341

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1988.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06342

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1985. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06343

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1986. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06344

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1986. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06345

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1987. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06346

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1987. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06347

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1985.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06348

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1986.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06349

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1987.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06350

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1988.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06351

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1986. VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06352

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1986 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06353

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1987 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06354

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1987 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06355

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1988 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06356

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1988 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06357

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1985.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06358

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1986.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06359

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1987.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06360

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1988.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06361

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1986.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06362

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1987.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06363

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1988.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06364

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984 VOLUME 1B: NORTHEAST FLORIDA - GROUNDWATER.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06365

WATER RESOURCES DATA FLORIDA, WATER YEAR 1984, VOLUME 2A: SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06366

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984, VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06367

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 3B: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06368

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1984, VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06369

WATER RESOURCES DATA - FLORIDA, WATER YEAR 1985, VOLUME 1A: NORTHEAST FLORIDA-SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06370

WATER RESOURCES DATA - FLORIDA, WATER YEAR 1985, VOLUME 1B: NORTHEAST FLORIDA - GROUNDWATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06371

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06372

WATER RESOURCES DATA FOR FLORIDA WATER YEAR 1985. VOLUME 3B: SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06373

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1985 VOLUME 4: NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06374

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1984.
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06375

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1984. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06376

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1984. VOLUME 2. GUAM, NORTHERN MARIANA ISLANDS, FEDERATED STATES OF MICRONESIA, PALAU, AND AMERICAN SAMOA.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06377

Group 2F—Groundwater

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1985. VOLUME 1: HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06378

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1984.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06379

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1984 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06380

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1984 VOLUME 2. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06381

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1985. VOLUME 1: ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06382

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1985 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06383

WATER RESOURCES DATA FOR INDIANA. WATER YEAR 1984.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06384

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1984.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06385

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1984.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06386

WATER RESOURCES DATA FOR KANSAS WATER YEAR 1985.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06387

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1984.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06388

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1986.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06389

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1988.
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06390

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1986.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06391

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1987.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06392

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1988.
Geological Survey, Louisville, KY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06393

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1986.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06394

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1987.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06395

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1988.
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06396

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1985.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06397

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1986.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06398

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1987.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06399

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1988.
Geological Survey, Augusta, ME. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06400

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1986.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06401

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1987.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06402

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1988.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06403

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1985.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06404

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1986.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06405

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1986.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06406

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1987.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06407

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1988.
Geological Survey, Lansing, MI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06408

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1984. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06409

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1985. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06410

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1985. VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.

Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06411

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1986. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06412

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1986. VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06413

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1985.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06414

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1986.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06415

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1987.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06416

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1988.
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06417

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1988.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06420

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1986. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06421

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1986. VOLUME 2. COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06422

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1987. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06423

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1987. VOLUME 2. COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06424

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1988.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06425

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1985.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06426

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1986.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06427

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1987.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06428

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1988.
Geological Survey, Lincoln, NE. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06429

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1985.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06430

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1986.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06431

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1987.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06432

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1985.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06433

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1986.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06434

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1987.
Geological Survey, Boston, MA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06435

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1986. VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06436

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1986. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06437

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1987. VOLUME 1: ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06438

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1987. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06439

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1988, VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06440

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1988. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06441

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1986.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06442

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1987.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06443

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1988.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06444

Group 2F—Groundwater

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06445

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985, VOLUME 2. LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06446

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06447

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06448

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 2: LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06449

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06450

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06451

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 2: LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06452

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06453

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06454

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 2. LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06455

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 3. WESTERN NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06456

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1985.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06457

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1984.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06458

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1985.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06459

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1984. VOLUME 1. OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06460

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1984. VOLUME 2. ST. LAWRENCE RIVER BASIN, STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06461

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1985. VOLUME 1. OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06462

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1985. VOLUME 2. ST. LAWRENCE RIVER BASIN, STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06463

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1984. VOLUME 1. EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06466

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1984. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06467

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06468

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06469

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1984.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06470

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1985.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06471

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1984.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06472

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1984.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06476

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1985.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06477

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1984.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06478

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1986.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06479

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1987.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06480

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1988.
Geological Survey, Raleigh, NC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06481

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1986.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06482

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1987.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06483

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1988.
Geological Survey, Bismarck, ND. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06484

WATER RESOURCES DATA FOR OHIO, 1986. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06485

WATER RESOURCES DATA FOR OHIO, 1986. VOLUME 2: ST. LAWRENCE RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06486

WATER RESOURCES DATA FOR OHIO, 1987. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06487

WATER RESOURCES DATA FOR OHIO, 1987. VOLUME 2: ST. LAWRENCE RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06488

WATER RESOURCES DATA FOR OHIO, 1988. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06489

WATER RESOURCES DATA FOR OHIO, 1988. VOLUME 2: ST. LAWRENCE RIVER BASIN AND STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06490

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1982. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06493

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1982. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06494

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1985. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06495

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06499

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06500

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06501

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06502

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06503

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06504

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06505

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1987. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06506

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1987. VOLUME 3, OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06507

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06508

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06509

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06510

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1985.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06511

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1986.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06512

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1987.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06513

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1988.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06514

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1985.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06515

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1986.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06516

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1987.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06517

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1986.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06518

Group 2F—Groundwater

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1987.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06519

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1988.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06520

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1986.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06521

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1987.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06522

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1988.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06523

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1986.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06536

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1987.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06537

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1988.
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06538

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1986.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06539

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1987.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06540

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1988.
Geological Survey, Richmond, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06541

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1984.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06542

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1986.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06543

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1985.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06544

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1986.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06545

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1987.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06546

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1986.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06547

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1987.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06548

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1988.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06549

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1985.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06550

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1986.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06551

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1987.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06552

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1988.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06553

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1985.
Geological Survey, Iowa City, IA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06554

2G. Water In Soils

AERATION CHANGES AFTER IRRIGATION IN A CLAY SOIL.
Sveriges Lantbruksuniversitet, Uppsala. Div. of Agricultural Hydrotechnics.
For primary bibliographic entry see Field 3F.
W90-05915

SCALING THE SATURATED HYDRAULIC CONDUCTIVITY OF AN ALFISOL.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
M. Bonsu, and K. B. Laryea.
Journal of Soil Science JSSCAH, Vol. 40, No. 4, p 731-742, December 1989. 7 fig, 3 tab, 19 ref.

Descriptors: *Alfisols, *Data interpretation, *Hydraulic conductivity, *Hydraulic models, *Laboratory methods, *Mathematical models, *Permeability coefficient, *Scale factors, *Soil porosity, *Soil saturation, Hydraulic permeability, Semiarid climates, Soil properties, Soil types, Tropical regions.

Alfisols occupy about 30% of the land area in the semi-arid tropics, but their low water-holding capacity owing to their characteristically shallow depth is one of the major constraints to sustained crop production. Alfisols exhibit a high degree of spatial variability in their physical properties. As a result, it is difficult to use information on physical parameters measured at one location to model larger-scale hydrologic processes. In this study, the saturated hydraulic conductivity, K sub s, of an Alfisol was determined on 109 undisturbed monoliths using the falling-head permeameter method. A model developed by Arya and Paris was used to calculate the port volume from sand and clay fractions. Scaling factors were calculated from the measured K sub 2, sand pore-volume, clay content and effective porosity, using the similar media concept. Prediction of K sub s of gravelly Alfisol using clay port volume is confounded by high gravel content which, when discounted, improves the prediction remarkably. The scaled mean saturated hydraulic conductivity K* for all horizons of the Alfisol was approximately 10 micrometers/sec. (Author's abstract)
W90-05916

EFFECT OF BULK DENSITY, WATER CONTENT AND SOIL TYPE ON THE DIFFUSION OF CHLORIDE IN SOIL.
Queensland Univ., Brisbane (Australia). Dept. of Agriculture.
H. B. So, and P. H. Nye.
Journal of Soil Science JSSCAH, Vol. 40, No. 4, p 743-749, December 1989. 3 fig, 1 tab, 7 ref.

Descriptors: *Chlorides, *Diffusion coefficient, *Impedance, *Soil density, *Soil types, *Soil water, *Solute transport, Clay loam, Loam, Soil compaction, Soil porosity, Soil water potential.

The relative importance of soil bulk density, water content and water potential on the self-diffusion and impedance factors of Cl(36) in a sandy loam and loamy clay were studied. The soils used were cultivated topsoils of Begbroke sandy loam and Evesham silty clay and the soil bulk densities used represented a range of conditions from freshly tilled seedbeds to compacted soils. Results showed that the relationship between water potential and the gravimetric water content is independent of the soil bulk density, except near saturation. The volumetric water contents and water potential were the main factors controlling the soil impedance factors, with bulk density making a small but significant contribution. There was no significant reduction in the residual variance of the impedance factor if the interaction between bulk density and volumetric water content or water potential was included in the regression equations. Soil type affects the impedance factors through differences in anion exclu-

sion volumes, the water contents of poorly connected pores that contribute little to the diffusion process, and tortuosity of the diffusion pathways. (Author's abstract)
W90-05917

COMPARISON BETWEEN ACETONE AND DIOXANE AND EXPLANATION OF THEIR ROLE IN WATER REPLACEMENT IN UNDISTURBED SOIL SAMPLES.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
For primary bibliographic entry see Field 7B.
W90-05918

SOURCES OF ACIDITY IN FOREST-FLOOR PERCOLATE FROM A MAPLE-BIRCH ECOSYSTEM.
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 5B.
W90-05982

ENVIRONMENTAL CHEMISTRY OF HERBICIDES. VOLUME I.
For primary bibliographic entry see Field 5B.
W90-06164

MASS FLOW AND DISPERSION.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 5B.
W90-06166

2H. Lakes

BIBLIOGRAPHY OF FISHERY INVESTIGATIONS ON LARGE SALMONID RIVER SYSTEMS WITH SPECIAL EMPHASIS ON THE BOIS BRULE RIVER, DOUGLAS COUNTY, WISCONSIN.
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 10C.
W90-05735

FISHERIES-OCEANOGRAPHY COORDINATED INVESTIGATIONS--FIELD OPERATIONS 1988.
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 8I.
W90-05737

EFFECT OF DISSOLVED OXYGEN CONCENTRATIONS ON FISH AND INVERTEBRATES IN LARGE EXPERIMENTAL CHANNELS.
Tennessee Valley Authority, Knoxville. Office of Natural Resources and Economic Development.
For primary bibliographic entry see Field 5C.
W90-05751

DISSOLVED ORGANIC MATTER AND LAKE METABOLISM: BIOGEOCHEMISTRY AND CONTROLS OF NUTRIENT FLUX DYNAMICS IN LAKES.
Michigan Univ., Ann Arbor. Dept. of Biology.
R. G. Wetzel.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-016540. Price codes: A04 in paper copy, A01 in microfiche. Report No. DOE/ER/60515--2-Pt. 1, (1988). 56p, 6 fig, 27 ref. DOE Contract DE-FG02-87ER60515.

Descriptors: *Nutrients, *Fluctuations, *Water chemistry, *Lake morphology, *Limnology, *Cycling nutrients, *Lakes, Organic matter, Wetlands, Phytoplankton, Littoral environment, Ecosystems.

The littoral-wetland vegetation and its intensive synthesis and decompositional metabolism of lakes regulate: (1) loading of inorganic nutrients passing to the open water (functioning as pulsed sources and sinks), and (2) loading of dissolved organic matter and particulate organic matter to the recipient open water, which by numerous complex pathways and mechanisms enhance or suppress pelagic productivity. Recent investigations have addressed the sources, fates, and interactions of dissolved and particulate organic matter in relation to: (1) inorganic chemical cycling, (2) allochthonous loading to the lake system, and (3) the coupled nutrient physiology and metabolism of phytoplankton, bacterial populations, macrophytes and attendant sessile algal-bacterial communities. Regulatory mechanisms of growth and rates of carbon and nutrient cycling were evaluated among the: (1) inorganic-organic influxes of allochthonous sources as they are controlled by wetland-littoral communities, (2) wetland and littoral photosynthetic producer-decomposer complex, (3) microflora of the sediment-water interface, and (4) microflora of the pelagic zone as influenced by other components. The research components summarized are by necessity long-term and continuing. Facets have been in progress for over a decade, during which experimental subprograms to evaluate regulatory mechanisms were executed within long-term quantitative analyses of population, community, and ecosystem dynamics. (Lantz-PTT)
W90-05753

EFFECTS OF TEMPERATURE AND REDOX CONDITIONS ON DEGRADATION OF CHLORINATED PHENOLS IN FRESHWATER SEDIMENTS.
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W90-05756

TRACE ELEMENT CONCENTRATIONS IN TRANSPLANTED AND NATURALLY OCCURRING UNIONIDAE MUSSELS, WATER, SEDIMENTS, AND MACROPHYTES IN CAYUGA LAKE.
Department of Energy, New York. Environmental Measurements Lab.
For primary bibliographic entry see Field 5B.
W90-05763

HISTORICAL SYNOPSIS OF GREAT LAKES WATER QUALITY RESEARCH AND MANAGEMENT AND FUTURE DIRECTIONS.
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
For primary bibliographic entry see Field 5B.
W90-05778

ION EXCHANGE IN FISH UNDER EXTREME EFFECTS OF A VARIED NATURE.
Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.
For primary bibliographic entry see Field 5C.
W90-05781

VOLUNTEER LAKE MONITORING PROGRAM, 1987. VOLUME VI: SOUTHWESTERN ILLINOIS REGION.
Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
M. E. Clement, and S. E. Andres.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-166797. Price codes: A04 in paper copy, A01 in microfiche. Report No. IEPA/WPC/88-016f, November 1988. 79p, 20 fig, 15 tab, 23 ref, 2 append.

Descriptors: *Data acquisition, *Illinois, *Lakes, *Monitoring, *Public participation, *Water quality control, Algae, Color, Data collections, Hydrologic data, Organic matter, Secchi disks, Suspended sediments, Turbidity.

Illinois has more than 2900 lakes of 6 acres or more. These lakes comprise a valuable resource essential to the economic health of the State. Recognizing the need to assess the quality of Illinois lakes and devise protection and management strategies, Illinois EPA began investigating lakes in 1987. As a result of these early studies and growing public interest, the Volunteer Lake Monitoring Program (VLMP) was initiated in 1981. The intent of the VLMP was to involve citizen volunteers with lake monitoring, thereby providing public education in lake/watershed management, and at the same time to establish a lake information base which could be used to help diagnose lake problems and support lake management decision making. The volunteer lowers a Secchi disc into the water and records the depth at which it disappears from view to determine light penetration into a body of water. This measurement can be used to document changes in transparency of lake water due to algae, sediment and organic matter, which interfere with light penetration. The volunteer also records observations about other important environmental characteristics of the lake, such as water color, suspended algae and sediment, aquatic weeds and odor. Weather conditions on the day of sampling, as well as during the prior week, are recorded. Any recent lake management activities or other factors which could impact the lake are documented. VLMP data for 9 lakes in the Southwestern Illinois Region are organized as follows: (1) summary of 1987 regional results, discussion of lake characteristics, volunteer participation, ranking of lakes on a regional basis and comparison to statewide statistics; (2) individual lake summaries for those VLMP lakes that were monitored for nine or more periods during the 1987 season; and (3) individual lake data (in tabular and graphic form) for those VLMP lakes in the region which were monitored between four and eight sampling periods during the 1987 season. (Lantz-PTT)
W90-05827

LIPID COMPOSITION RELATED TO SIZE AND MATURITY OF THE AMPHIPOD PONTOPOREIA HOYI.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
M. A. Quigley, J. F. Cavaletto, and W. S. Gardner.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 601-610, 1989. 5 fig, 51 ref.

Descriptors: *Amphipods, *Lipids, *Path of pollutants, Lake Michigan, Life history studies, Physiology, Sex, Size, Triacylglycerol.

Micro-gravimetric determination of the lipid content of amphipods (Pontoporeia hoyi) obtained from a 45-m-deep Lake Michigan sampling site indicated that the mean lipid content of adult females was 30% on a non-lipid dry weight (NLDW) basis, and that juveniles and adult males contained 21 and 10% lipid (NLDW basis), respectively. Thin layer chromatography-flame ionization detection analysis revealed that lipids of females were composed primarily of triacylglycerols (81%), the principal energy storage lipid of amphipods. Lipids of juveniles were composed largely of triacylglycerols (41%) and phospholipids (44%). Adult male P. hoyi lipids consisted mostly of phospholipids (64%) and, secondarily, of triacylglycerols (12%). The relatively low triacylglycerol concentrations in males may be associated with the minimal requirements for energy stores to support metabolic needs during the male's brief (10 day) life span. By contrast, the high lipid content and marked abundance of triacylglycerols in adult females represents an important energy store supporting subsequent egg development, particularly since females appear to halt all feeding upon maturation. In juvenile P. hoyi, increased individual size (NLDW) was accompanied by increased lipid dry weight, implying that juveniles accumulate lipids during growth. Overall, the results demonstrated the importance of considering P. hoyi size, life stage, and sex when describing a population's lipid content or composition. This consideration is particularly critical when evaluating the role of P. hoyi in the transfer of energy and/or organic contaminants within the Great Lakes food web. (Author's abstract)
W90-05846

SOME PROBLEMS AFFECTING THE ASSESSMENT OF GREAT LAKES WATER QUALITY USING BENTHIC INVERTEBRATES.
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5A.

W90-05847

USE OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) TO MONITOR THE NEAR-SHORE ENVIRONMENT OF LAKES.
University of Western Ontario, London. Dept. of Zoology.
For primary bibliographic entry see Field 5A.
W90-05849

DEVELOPMENT OF A BENTHIC INVERTEBRATE OBJECTIVE FOR MESOTROPHIC GREAT LAKES WATERS.
Canada Centre for Inland Waters, Burlington (Ontario).
T. B. Reynoldson, D. W. Schloesser, and B. A. Manny.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 669-686, 1989. 5 fig, 7 tab, 81 ref.

Descriptors: *Benthic fauna, *Bioindicators, *Great Lakes, *Lake restoration, *Macroinvertebrates, *Mesotrophic lakes, Environmental effects, Mayflies, Monitoring, Oligochaetes, Spatial variation, Tubificids.

A biological indicator of mesotrophic conditions should: (1) provide an appropriate and interpretable objective; (2) be achievable if corrective measures are taken (i.e., it should be within the expected environmental range of the system); and (3) allow measurement of progress toward the objective. Historical data from the Great Lakes suggest that population density of the burrowing mayfly, Hexagenia limbata, could provide an appropriate objective, and that the tubificid oligochaete community can be used to evaluate progress toward that objective. Even though Hexagenia has not returned to the western basin of Lake Erie, there has been a change toward mesotrophy in the lake as evidenced by the tubificid oligochaete community structure. Furthermore, trends in the status of the benthic community can be tracked by observation of the benthic community. Data from other systems show that Hexagenia can return to locations where it was formerly abundant, and therefore is an attainable objective for formerly mesotrophic ecosystems. It is recommended: (1) that historic data bases be made more widely available and analyzed more precisely to document spatial changes and confirm the exact nature of the decline in Hexagenia; (2) that more detailed information be acquired on the environmental requirements of Hexagenia; and (3) that the entire benthic community be monitored on a regular basis at key locations to track progress toward attaining the desired objective. (Author's abstract)
W90-05852

VARIABILITY OF PHOSPHORUS FORMS IN SUSPENDED SOLIDS AT THE LAKE ERIE-GRAND RIVER CONFLUENCE.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2K.
W90-05853

CLADOPHORA INTERNAL PHOSPHORUS MODELING: VERIFICATION.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
D. S. Painter, and M. B. Jackson.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 700-708, 1989. 10 fig, 1 tab, 16 ref.

Descriptors: *Algal blooms, *Chlorophyta, *Eutrophic lakes, *Limnology, *Phosphorus, *Simulation analysis, Canale and Auer model, Cladophora, Great Lakes, Model studies, Monitoring, Temperature, Transparency.

A mathematical model, simulating Cladophora internal phosphorus, was developed from relationships reported by Canale and Auer. The 'Environment Canada' model was intended to be a simplified generic growth model that would indicate the potential for Cladophora problems to develop at a specific site. The environmental conditions required for simulation of internal phosphorus were temperature, Secchi disc transparency, and soluble reactive phosphorus. The model inputs were simplified and some model equations and coefficients were modified from the original Canale and Auer model and therefore the present model required verification. The model's response was evaluated over a broad range of environmental conditions using data sets obtained from Lakes Ontario, Erie, Huron, and Simcoe. An assessment of the model's predictions suggests that monitoring programs designed to observe trends in eutrophication should concentrate on shoreline samples only. The internal phosphorus concentration in the shore samples is dependent on ambient phosphorus concentration and relatively independent of temperature and clarity. Therefore, an analysis of historical trends in eutrophication using shore samples only would be more valid and less susceptible to year-to-year climatic or storm-induced factors. (Author's abstract)
W90-05854

RESPONSE OF SPORT FISHES TO THERMAL DISCHARGES INTO THE GREAT LAKES: IS SOMERSET STATION, LAKE ONTARIO, DIFFERENT.
State Univ. of New York Coll. at Brockport. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-05855

DETECTING ACID PRECIPITATION IMPACTS ON LAKE WATER QUALITY.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 7A.
W90-05860

LAKE MANAGEMENT TECHNIQUES IN FLORIDA, USA: COSTS AND WATER QUALITY EFFECTS.
Florida Inst. of Tech., Melbourne. Dept. of Chemical and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W90-05867

'MINOR' WETLANDS AS A HABITAT FOR SNIPES IN ITALY: PRESENT SITUATION AND PERSPECTIVES (LE ZONE UMIDE 'MINORI' ITALIANE COME HABITAT PER I BECCACCINI: SITUAZIONE E PROSPETTIVE).
M. N. Raniero.
Ricerche di Biologia della Selvaginna, No. 82, p 1-19, 1989. 2 fig, 12 ref. English summary.

Descriptors: *Birds, *Italy, *Rice, *Wetlands, *Wildlife habitats, Bioindicators, Field drainage, Herbicides, Snipes.

In order to analyze the dramatic decrease in the snipe habitat in Italy, a questionnaire was sent to 50 experienced correspondents. Habitats were classified as natural (swamps, marshlands, grasslands) and artificial (rice paddies). For the first group, data came back from 146 questionnaires that covered the same number of swamps, marshlands, and grasslands existing in 24 Italian provinces, from Venice to Palermo. In 1965 these 146 wetlands extended over 32.068 ha; in 1987 they were reduced to 6.036 ha, with a decrease of 81%. The snipe bags (harvests) on the same 146 natural wetlands, diminished from 8.1 in 1965 to 1.0 in 1987 (average bag for one hunter in 4 hours activity); bag reduction was 88%. Research on the habitat of the snipe in Italian rice paddies gave somewhat different data. The total area covered by rice paddies in Italy, mostly concentrated in Piedmont and Lombardy regions, went from 160,000 ha in 1965 to 190,000 in 1987. This 19% increase brought no increase in Snipes: data from 12 questionnaires from six provinces showed that the average bag went from 10.4 (1965) to 2.2 (1987), with a reduction of 79%. Italy has in fact recently reached a worldwide supremacy in rice production/hectare: more than 6000 kg. This means a highly negative impact on snipes, caused by the continuous use of herbicides (Molinate), total field drainage, a high degree of mechanization with complete cutting of rice plants. Snipe bag statistics are thought to be reliable environmental indicators. The 1986 agreement between farmers' and hunters associations, to work together for a better wildlife habitat conservation, should immediately be implemented in the Italian snipe areas. (Author's abstract)
W90-05881

INFLUENCE OF TWO TRIAZINE HERBICIDES ON THE PRODUCTIVITY, BIOMASS AND COMMUNITY COMPOSITION OF FRESHWATER MARSH PERIPHYTON.
Manitoba Univ., Winnipeg. Dept. of Botany.
For primary bibliographic entry see Field 5C.
W90-05894

INFLUENCE OF NITROGEN SUPPLY RATES ON GROWTH AND NUTRIENT STORAGE BY WATER HYACINTH (EICHHORNIA CRASSIPES) PLANTS.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
K. R. Reddy, M. Agami, and J. C. Tucker.
Aquatic Botany AQBODS, Vol. 36, No. 1, p 33-43, December 1989. 7 fig, 3 tab, 30 ref.

Descriptors: *Nitrogen, *Nitrogen removal, *Nutrients, *Plant growth, *Wastewater treatment, *Water hyacinth, *Water pollution treatment, Aquatic plants, Aquatic productivity, Metabolism, Nutrient removal, Plant tissues.

Aquatic plants play a significant role in stripping nutrients from polluted waters and they may be a valuable source of protein and as a feedstock to produce methane. The effect of nitrogen (N) levels of the culture medium (0.5 to 50.5 mg N/L or 38 to 3820 mg N/sq m/day) on net productivity and nutrient (N, phosphorus (P) and potassium (K)) storage by water hyacinth (Eichhornia crassipes (Mart.) Solms) plants was investigated using outdoor tanks. Net productivity increased with N supply rate of up to 5.5 mg N/L) or 416 mg N/sq m/day); higher concentrations did not significantly increase the yield. The net productivity increased until plant tissue N content reached 16 mg N/g dry weight, but additional increase in tissue N content did not improve yield. However, N storage in the plant tissue increased in response to N supply rate with maximum N storage (80 g N/sq m) measured in plants cultured at 50.5 mg N/L. Plant density affected N storage in the tissue; when water hyacinths were cultured in N-limited water, plant tissue-N decreased by 75% within 4 weeks of growth. The storage of P and K in the plant tissue was increased up to 5.5 mg N/L and 2.5 mg N/L in the culture medium, respectively. (Author's abstract)
W90-05895

ATMOSPHERIC DEPOSITION OF PERSISTENT POLLUTANTS GOVERNS UPTAKE BY ZOOPLANKTON IN A POND IN SOUTHERN SWEDEN.
Lund Univ. (Sweden). Dept. of Ecology.
For primary bibliographic entry see Field 5B.
W90-05903

ECOLOGICAL GENETICS OF DAPHNIA: RESPONSE OF COEXISTING GENOTYPES TO RESOURCE MANIPULATION.
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Dept. of Ecophysiology.
M. A. Mort, W. Fleckner, W. Lampert, and H. G. Wolf.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 2, p 141-161, December 1989. 7 fig, 4 tab, 48 ref.

Descriptors: *Daphnia, *Ecology, *Genetics, *Glacial lakes, Algae, Crustaceans, Electrophoresis, Eutrophic lakes, Genotypes, Population density, Reproduction, West Germany.

The crustacean waterflea Daphnia is a useful organism for ecological genetics studies because it exhibits both asexual and sexual reproduction. Large-scale enclosures (1500 L) were used to manipulate

Daphnia galeata populations to investigate responses of 2-locus genotypes (Pgi-Pgm) to addition of the green alga Scenedesmus. Experiments were conducted in the moderately eutrophic Schohsee, a lake of glacial origin in northern Germany. Four experiments were conducted in summer and autumn over a 2-year period; the experiments ranged from 40 to 57 days in duration. Enclosures to which algae were added represented conditions in which a highly preferred resource was offered continually; enclosures without algae added represented 'control enclosures' in which a declining resource base created conditions of resource stress. Responses to individual genotypes to these treatments were followed electrophoretically using allozyme markers. During the experiments, diversity and relative abundances of genotypes exhibited little change, despite large changes in total abundances of the enclosed populations. These results are consistent with predictions based on previous genetic studies of large-lake Daphnia species. (Mertz-PTT)
W90-05919

MULTIVARIATE ANALYSIS OF LAKE PHYTOPLANKTON AND ENVIRONMENTAL FACTORS.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
O. Varis, H. Sirvio, and J. Kettunen.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 2, p 163-175, December 1989. 4 fig, 3 tab, 27 ref.

Descriptors: *Algae, *Algal blooms, *Cyanophyta, *Eutrophic lakes, *Eutrophication, *Finland, *Multivariate analysis, *Phytoplankton, *Species composition, *Water pollution effects, Ammonium, Anabaena, Aphanizomenon, Canonical correlation, Chlamydomonas, Melosira, Microcystis, Nitrogen, Oscillatoria, Pediastrum, Phosphorus, Water pollution, Water quality, Water temperature.

The water quality of Lake Enajarvi, Southern Finland, has deteriorated strongly due to eutrophication, especially by high summertime biomasses of cyanobacteria (bluegreen algae). According to 88 algal counts available from the years 1977-1981, the greatest problems were caused by Anabaena, Aphanizomenon, Microcystis and Oscillatoria. Also other phytoplankton genera, such as Melosira, Chlamydomonas and Pediastrum were observed to form blooms. Of a number of multivariate techniques used to find associations between the algal taxa and selected environmental factors, canonical correlation analysis appeared the most applicable. Canonical correlations were used in defining the roles of selected environmental variables in the algal associations. A very distinct cluster of the most dominant cyanobacteria was formed. The taxa in the cluster had a strong positive correlation with total phosphorus and water temperature, and a negative correlation with the N/P ratio and ammonium. A number of diatoms formed a cluster which correlated with nitrate. Despite the difficulty of dealing with the numerous zero-valued observations, the method used was efficient, and yielded information applicable in further studies, such as dynamic models, and in the management of the lake. (Author's abstract)
W90-05920

TOTAL NITROGEN AND PHOSPHORUS BUDGETS IN THE LOWLAND SULEJOW RESERVOIR.
Lodz Univ. (Poland). Dept. of Ecology and Vertebrate Zoology.
W. Galicka, and T. Penczak.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 2, p 177-190, December 1989. 2 fig, 7 tab, 31 ref.

Descriptors: *Cycling nutrients, *Eutrophication, *Nitrogen, *Phosphorus, *Poland, *Reservoirs, *Water pollution effects, *Water quality, Chemical properties, Drinking water, Flood protection, Flow discharge, Hydroelectric power, Influent streams, Irrigation, Organic loading, Precipitation, Recreation, Stream fisheries, Surface runoff, Water chemistry, Water sampling.

The Sulejow Reservoir, in Poland, was filled with water in 1973. The dam is located at km 139 of the Pilica River, where the river flows across glacial chalk sediments. The Sulejow River is the main drinking water source for the Lodz Conurbation, but fulfills several other functions: flood protection, irrigation, recreation, fisheries, and hydroelectric power production. Four sampling sites were established at the reservoir. Sites 1 and 2 were located in the Pilica and Luciaza Rivers near their points of discharge into the reservoir. These were selected for estimating the inflow of nutrients. Site 3 was located at the drinking water intake, and site 4, downstream from the dam. Total nutrient loadings of the Sulejow Reservoir, in four successive years (1981-1984) were 34.6, 41.8, 37.6, and 16.1 g of total N and 5.4, 10.9, 6.5, and 1.5 g total P per square meter of reservoir area, respectively. These nutrients entered the reservoir mainly through its two largest tributaries, the Pilica and Luciaza Rivers. These inputs constituted from 94.5 % to 98.2 % of the total nitrogen and from 94.8 % to 98.7 % of the total phosphorus in the reservoir. The contributions to the nutrient inputs from surface runoff, precipitation, and bird excreta, and that due to tourist activity were low. The mean annual discharges of the Pilica River in the four study years were 27.9, 27.2, 20.0, and 12.8 cubic meters/sec, respectively, and 5.41, 5.4, 3.6, and 2.7 cubic meters/sec, respectively for the Luciaza River. The residence times of the water in Sulejow Reservoir were estimated to be 16 days for 1981, 15 days for 1982, 22 days for 1983, and 40 days for 1984. (Mertz-PTT)
W90-05921

RELATIONSHIP BETWEEN BODY LENGTH PARAMETERS AND DRY MASS IN RUNNING WATER INVERTEBRATES.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
E. Meyer.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 2, p 191-203, December 1989. 8 tab, 13 ref.

Descriptors: *Biomass, *Invertebrates, *Lotic environment, *Stream biota, Benthic fauna, Caddisflies, Diptera, Ecology, Gastropods, Hydracarina, Hydrozoa, Insects, Nemathelminthes, Oligachaetes, Stoneflies, West Germany.

Invertebrates were collected at several occasions between November, 1985 and October, 1987 in the Steina, a Black Forest mountain stream, southern West Germany. Common methods for biomass determinations are either direct weighing of preserved specimens of length-dry mass conversions. Body mass estimations from length-body mass relationships were used in this study. Length-dry mass relationships can be best described by the power equation y = a times x to the b power or a quadratic regression model y = a + bx + c times x squared. Correlation between length parameters, i.e. between head capsule width and body length, is either linear or follows a quadratic regression model, too. Average dry mass values are provided for several taxa for which body size measurements often are not carried out in quantitative studies, e.g. Hydrozoa, Nemathelminthes, Oligochaeta, Hydracarina and pupae of Trichoptera and Diptera. Length-dry mass relationships and mean dry mass values for 37 species of Central European stream-dwelling invertebrates (Gastropoda, Ephemeroptera, Plecoptera, Trichoptera, and Diptera) are given to enable calculation of benthic biomass. (Mertz-PTT)
W90-05922

GONYOSTOMUM SEMEN, A POTENTIAL NUISANCE IN LARGE FRENCH RESERVOIRS. THE CASE OF THE PARELOUP LAKE (GONYOSTOMUM SEMEN (RAPHIDOPHYCEES), NUISANCE POTENTIELLE DES GRANDS RESERVOIRS FRANCAIS. L'EXEMPLE DU LAC DE PARELOUP).
Toulouse-3 Univ. (France). Lab. d'Hydrobiologie.
P. R. Le Cohu, J. Guitard, N. Comoy, and J. Brabet.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 2, p 225-236, December 1989. 4 fig, 27 ref.

Descriptors: *Flagellates, *France, *Population dynamics, *Reservoirs, Biomass, Chlorophyll, Gonyostomum, Nitrogen, Phosphorus, Phytoplankton, Seasonal variation, Spatial distribution.

The temporal and spatial distribution of the flagellate Gonyostomum semen (Ehr.) Diesing was followed in a large and deep reservoir in France in 1987. The seasonal growth showed great fluctuations during the summer stratification. The maximum population doubling time was 1.5 days. The vertical distribution depended on the thermal cycle. In summer, the motile cells tended to aggregate at the depths associated with low light intensity, about 80 microns Einstein/square meter/second. During the same period, Gonyostonum semen could range from 3 % to 60 % of the total phytoplankton biomass. In autumn, Gonyostonum dominated the phytoplankton and represented from 40 to 60% of the total biomass. The chlorophyll a content increased significantly only when the Gonyostomum biomass reached about 65 % of the total biomass. During the summer stratification, low specific photosynthetic rates were observed at the depth where the cells of Gonyostomum biomass and the nutrients (N and P) could never be demonstrated. (Author's abstract)
W90-05924

BENTHIC MACROINVERTEBRATE COMMUNITY STRUCTURE IN A BACKWATER LAKE OF POOL 2, UPPER MISSISSIPPI RIVER.
Macalester Coll., St. Paul, MN. Dept. of Biology.
D. J. Hornbach, and A. C. Miller.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 131-138, December 1989. 3 fig, 2 tab, 10 ref. National Science Foundation College Science Instrumentation Program, Grant No. CSI-8750483.

Descriptors: *Benthic fauna, *Lakes, *Macroinvertebrates, *Mississippi River, *Oxbow lakes, *Species composition, Biomass, Hexagenia, Mayflies, Midges, Oligochaetes, Organic matter, Population density, Tanypus.

The benthic community structure of a backwater lake of the upper Mississippi River was examined based on samples taken in July, 1986. The dominant taxa based on density were the midge Tanypus, followed by the naidid and tubificid oligochaetes and the mayfly Hexagenia. Based on biomass, however, Hexagenia was the dominant taxon. The species found were similar to those reported for other backwater lakes of the Mississippi River, although the relative abundances of various taxa were different. A canonical correlation analysis of habitat factors (based on sediment grain size and organic content) with community characters (densities of all taxa found) indicated that the percent sediment organic matter was the most important factor influencing the presence or absence of various taxa. Sediment particle size had a lesser association with the relative abundance of the major taxa. (Author's abstract)
W90-05927

FATE OF FRESHWATER MUSSELS TRANSPLANTED TO FORMERLY POLLUTED REACHES OF THE CLINCH AND NORTH FORK HOLSTON RIVERS, VIRGINIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 5G.
W90-05928

MICRO-BIOASSAY FOR EPILITHON USING NUTRIENT-DIFFUSING ARTIFICIAL SUBSTRATA.
Cincinnati Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-05931

AUTOTROPHIC-HETEROTROPHIC COMMUNITY METABOLISM RELATIONSHIPS OF A WOODLAND STREAM.
Central Michigan Univ., Mount Pleasant. Dept. of Biology.

For primary bibliographic entry see Field 2E.
W90-05932

FACTORS AFFECTING AUTOTROPHIC-HETEROTROPHIC RELATIONSHIPS OF A WOODLAND STREAM.
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
D. K. King, and K. W. Cummins.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 219-230, December 1989. 4 tab, 36 ref. Department of Energy Grant DE-AT06-79EV1004.

Descriptors: *Aquatic productivity, *Detritus, *Forest ecosystems, *Light quality, *Metabolism, *Stream biota, *Water temperature, Michigan, Periphyton, Respiration, Riffles, Standing crops.

The effects of incident light, temperature, and detrital and epilithon standing crops on aspects of community metabolism were investigated at five first to third order riffle sites of Augusta Creek, Michigan. Detrital standing crops ranged from 142 to 592 g/square meter ash free dry weight, while annual averages for the five sites ranged from 242.4 to 388.2 g/square meter ash free dry weight. Epilithon values were higher with annual averages of 1764 to 3508 g/square meter ash free dry weight, while individual estimates ranged from 1480 to 5030 g/square meter. Epilithon composed 80 to 93 % of the total organic matter of the riffle sediments. Rates of community productivity were most highly correlated with incident light (r = 0.52 to 0.57), followed by temperature (r = 0.33 to 0.64) and epilithon development (r = 0.3 to 0.42). Community respiration was most highly correlated with temperature (r = 0.64), while multiple regression indicated light (n = 1957) was more influential for predicting rates of net community productivity, gross community productivity, and net daily metabolism. The importance of epilithon as both an organic base within riffle communities and as an aid in predicting rates of community metabolism was demonstrated. (See also W90-05932 and W90-05934) (Author's abstract)
W90-05933

ESTIMATES OF DETRITAL AND EPILITHON COMMUNITY METABOLISM FROM PARTICLE-SIZED RIFFLE SEDIMENTS OF A WOODLAND STREAM.
Central Michigan Univ., Mount Pleasant. Dept. of Biology.
D. K. King, and K. W. Cummins.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 231-244, December 1989. 1 fig, 5 tab, 25 ref. Department of Energy Grant DE-AT06-79EV1004.

Descriptors: *Aquatic productivity, *Bottom sediments, *Detritus, *Forest ecosystems, *Periphyton, *Respiration, *Riffles, *Stream biota, Algae, Ecology, Estimating, Michigan, Particle size, Respirometry.

Estimates of net community productivity and community respiration were made with a Gilson respirometer at levels of light-saturated photosynthesis (15000 lux) and darkness for particle-sized detrital and inorganic fractions of riffle sediments from five sites (first to third order) of Augusta Creek, Michigan. Sediments were separated into detrital and inorganic fractions and particle-sized into > 4 mm, 1 mm, 250 micrometer, 75 micrometer and 0.45 micrometer fractions. Net community productivity as microliters $O2$/g/h ash free dry weight of detritus ranged from 1319.7 to 1687.6; both values were on 0.45 microliters $O2$/g/h on 75 micrometer particles. Detrital community respiration ranged from 15.1 microliters $O2$/g/h on 4 mm pieces to 738.8 microliters $O2$/g/h on 0.45 micrometer fractions, while epilithon community respiration ranged from nondetectable amounts for 250 micrometer sands to 241.9 microliters $O2$/g/h for 75 micrometer sands. Expressed on an areal basis to analyze the ecological impact of each particle size, detrital fragments were generally lower in all rates except community respiration ultrafine particulate organic matter. Little autotrophic potential existed in detrital communities at all sites, except where algal sloughing into detrital pools occurred. Epilithon rates were dominated by larger particles. Areal trends for sites mirrored in situ values of net community productivity and community respiration. The importance of the epilithon community in dictating the autotrophic-heterotrophic nature of riffle sections and the importance of measuring community metabolism on intact sediments were reinforced. (See also W90-05932 and W90-05933) (Author's abstract)
W90-05934

SIMULATION OF VERTICAL LIMNOLOGICAL GRADIENTS.
Wyoming Univ., Laramie. Dept. of Zoology and Physiology.
F. J. Rahel.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 247-252, December 1989. 3 fig, 21 ref. National Science Foundation BSR-8807200.

Descriptors: *Environmental gradient, *Laboratory equipment, *Lake stratification, *Limnology, *Oxygen, *Simulation, Benthic fauna, Chemical stratification, Density stratification, Gradients, Hypoxia, Oxygen gradients, Stratification, Temperature gradient, Thermal stratification, Vertical distribution, Water chemistry, Water temperature.

A simple and inexpensive method of simulating vertical limnological gradients is described. The method relies on density differences due to temperature to maintain a stratified water column. Water is stored in a head tank which also functions as an oxygen stripping column. Water flows by gravity to a chiller tank where it is cooled to the desired temperature. Next, it flows into the experimental tank through an inflow tube designed to produce a laminar flow across the tank bottom. The water is then siphoned out of the tank through an outflow tube and into a drain. Removal of oxygen or addition of other factors (e.g., hydrogen sulfide) in the head tank allows various chemical gradients to be established in association with the thermal gradient. Temperature and oxygen gradients can be created that are similar to those in temperate lakes during winter or summer stratification. Vertical stratification is created by moving a layer of cool, dense water across the bottom of a laboratory tank. The stratification is maintained due to the temperature-density relation of water. Hypoxia can be created by bubbling nitrogen gas to remove oxygen from the incoming water. Other vertical chemical gradients can be created in addition to those involving temperature and oxygen. Use of the method is illustrated by the reaction of benthic invertebrates to developing hypoxia such as might occur in a winterkill lake. (Mertz-PTT)
W90-05935

COPPER TOXICITY FOR BLUE-GREEN ALGAE WITH REFERENCE TO THEIR PHYSIOLOGICAL STATUS.
Humboldt-Univ. zu Berlin (German D.R.). Sektion Biologie.
V. Luederitz, A. Nicklisch, and B. Roloff.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 82, No. 4, p 449-459, December 1989. 7 fig, 1 tab, 25 ref.

Descriptors: *Algal growth, *Algicides, *Copper sulfate, *Cyanophyta, *Eutrophication, *Toxicity, Algal control, Biomass, Nitrates, Nuisance algae, Phosphorus, Physiological ecology.

Exponentially growing blue-green algae (Aphanizomenon gracile and Oscillatoria redekei) were treated with copper sulfate solution in semicontinuous culture to examine the effects of the algicide on algal physiology and routes of copper toxicity. To find possible copper resistant mutants, two copper-treated cultures of both species were continued for 4 mo. The effect of copper toxicity dependence on the cell status was studied by adding copper at different points of time of the light-dark cycle. There was no correlation between initial biovolumes in algae cultures and the estimated copper concentrations which caused growth reductions, indicating little copper uptake. In Aphanizomenon, biomass concentration is depressed rapidly after addition of sublethal copper concentrations with subsequent recovery. Oscillatoria also showed growth depression but no loss of biomass after addition of sublethal copper concentrations. Nitrate-fed algae were copper-sensitive to a high degree, but N2 fixing Aphanizomenon showed a lethal dose similar to the $NH4(+)$-fed algae. Nitrogen fixation was not more reduced than growth. In Aphanizomenon phosphorus limitation led to a raising of the toxicity threshold. No copper-resistant mutants were found in the long-term experiments. (Geiger-PTT)
W90-05938

TOLERANCE TOWARDS MERCURY OF CHLORELLA STRAINS DETERMINED BY ALGAL PLATING.
Rome Univ. (Italy). Dipt. di Biologia.
For primary bibliographic entry see Field 5C.
W90-05939

TEMPORAL AND SPATIAL DISTRIBUTION OF CHLOROPHYLL A IN LAKE VOLVI, GREECE.
Thessaloniki Univ., Salonika (Greece). Inst. of Botany.
M. Moustaka-Gouni.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 82, No. 4, p 475-485, December 1989. 6 fig, 2 tab, 20 ref.

Descriptors: *Chlorophyll a, *Eutrophic lakes, *Greece, *Limnology, *Phytoplankton, *Spatial distribution, *Temporal distribution, Biomass, Light intensity, Light penetration, Species composition.

Samples collected at 9:00 a.m. each day from Lake Volvi at depths of 0.1 m below the surface to a depth of 15 m were analyzed for chlorophyll a content of phytoplankton at approximately monthly and biweekly intervals from July 1985 to August 1986. Additional samples were taken from the surface water layer of 0-0.1 m. The monthly values of phytoplankton chlorophyll varied from 20 to 147 milligrams/sq m and were within the range characteristic of eutrophic waters. The seasonal and vertical pattern of chlorophyll followed that of the total phytoplankton biomass. The ratio of chlorophyll a to fresh weight biomass in the euphotic zone varied from 0.1 to 1.3%. Chlorophyll content of phytoplankton in Lake Volvi appeared to vary primarily with the species composition and to a lesser extent with the light. The chlorophyll maximum in May was made up of cryptophytes while the summer maxima were composed largely of cyanophytes. Diatoms were mainly responsible for the maximum in autumn, while in early spring diatoms and cryptophytes dominated. Chlorophyll a concentration displayed its minimum value in August 1986 when Lyngbya limnetica was dominant despite high phytoplankton biomass. In contrast, during the dominance of Aphanizomenon cf. flosaquae in August 1985, at lower phytoplankton biomass the chlorophyll concentration was much higher. A weak negative relationship was found between the chlorophyll content of biomass and the Secchi disk transparency, while the relationships between the chlorophyll content of biomass and the concentrations of nutrients in the euphotic zone were positive. (Geiger-PTT)
W90-05940

PLANARIANS IN TOXICOLOGY: I. PHYSIOLOGY OF SEXUAL-ONLY DUGESIA DOROTOCEPHALA: EFFECTS OF DIET AND POPULATION DENSITY ON ADULT WEIGHT AND COCOON PRODUCTION.
Illinois Univ. at Urbana-Champaign. Dept. of Veterinary Biosciences.
For primary bibliographic entry see Field 5A.
W90-05943

OMBROTROPHIC BOG AS A METHANE RESERVOIR.
Ottawa Univ. (Ontario). Dept. of Biology.
A. Brown, S. P. Mathur, and D. J. Kushner.
Global Biogeochemical Cycles GBCYEP, Vol. 3, No. 3, p 205-213, September 1989. 4 fig, 2 tab, 38

ref, append.

Descriptors: *Air pollution sources, *Methane, *Peat bogs, *Wetlands, Environmental effects, Hydraulic conductivity, Interstitial water, Land use, Methanogenesis, Soil porosity.

The distribution of methane in an ombrotrophic bog was examined by extracting the gas from different depths, using evacuated bottles and sampling tubes. Methane was extracted during 75 min, from 60 cm, 90 cm and 120 cm depths at 25 stations in a 24 meter-square area. The amount of methane extracted varied widely between samples, and this variation was greater within each depth than between the different depths. Approximately two and a half times as much methane was found at 90 cm and 120 cm depths as at 60 cm. The amount of methane from sites more than 60 cm below the surface can be correlated with the methane microbially produced from peat from the same site during laboratory incubations. Much less methane could be extracted from near-surface peat than from deeper levels, but laboratory incubations of peat from this level produced 10-fold more methane. The present results show that there is a considerable amount of methane trapped below 50 cm depth within an ombrotrophic bog, which was calculated to be 1.7 Ggm in the bog studied. This entrapped methane is suggested to reduce the hydraulic conductivity in the lower layers of the peat by blocking the soil pore spaces and preventing fluid movement; this in turn generates an elevated water table allowing the formation of a raised bog. It is further suggested that if this peat is disturbed by mining or farming, the entrapped methane could be released into the atmosphere and add to the atmospheric pollution by greenhouse gases. (Author's abstract)
W90-05950

KEJIMKUJIK PARK--ONE IN A FAMILY OF INTEGRATED WATERSHED STUDIES.
Atmospheric Environment Service, Downsview (Ontario). Long-Range Transport of Airborne Pollutants Program.
For primary bibliographic entry see Field 5B.
W90-05977

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THREE ACIDIC, OLIGOTROPHIC LAKES AND THEIR WATERSHEDS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5B.
W90-05981

VEGETATION, SOILS, AND ION TRANSFER THROUGH THE FOREST CANOPY IN TWO NOVA SCOTIA LAKE BASINS.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
For primary bibliographic entry see Field 2K.
W90-05984

PATTERNS OF WATER CHEMISTRY AMONG TWENTY-SEVEN OLIGOTROPHIC LAKES IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
B. Freedman, J. Kerekes, and G. Howell.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 119-130, July/August 1989. 3 fig, 3 tab, 33 ref.

Descriptors: *Acid rain, *Canada, *Chemical properties, *Lakes, *Mathematical analysis, *Oligotrophic lakes, Acidic water, Acidity, Alkalinity, Anions, Calcium, Chlorine, Color, Hydrogen ion concentration, Magnesium, Nova Scotia, Potassium, Sodium, Sulfates.

A cluster analysis was used to apportion 27 oligotrophic lakes in southwestern Nova Scotia into five multivariate groups on the basis of patterns of covariation of 11 chemical variables (Cl, SO4, Gran alkalinity, organic anions, Ca, Mg, K, Na, H(+), and color). These groups were described in terms of the average values of the chemical variables. All of the study are were acidic, ranging in pH from 6.0 to 4.2. The ionic chemistry of all of the lakes was dominated by Na and Cl from atmospheric inputs of marine aerosols. On average, Na comprised 65% of the total equivalents of cations, while Cl accounted for 55% of the total equivalents of anions. The other quantitatively important cations were Ca (averaging 14% of total cation equivalents), Mg (18%), H+ (8%), and K (3%), while the other important anions were SO4 (averaging 21% of total anion equivalents) and organic anions (24%). The relationships among the groups were investigated by an ordination by detrended correspondence analysis. The first, and by far the strongest axis of the ordination separated lakes with relatively large concentrations of alkalinity, from strongly colored lakes with large concentrations of H(+) and organic anions. Axis 2 separated acidic lakes from lakes with large concentrations of Ca and alkalinity. (Mertz-PTT)
W90-05985

ALUMINUM SPECIES IN POREWATERS OF KEJIMKUJIK AND MOUNTAIN LAKES, NOVA SCOTIA.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-05988

CHEMICAL CHARACTERIZATION OF SEVERAL WETLANDS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Canadian Wildlife Service, Hull (Quebec). Sustainable Development Branch.
J. A. Wood, and C. D. A. Rubec.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 177-186, July/August 1989. 1 fig, 4 tab, 14 ref.

Descriptors: *Acid rain, *Bogs, *Canada, *Chemical properties, *Fens, *Soil chemistry, *Water sampling, *Wetlands, Acidity, Alkalinity, Cations, Classification, Hydrogen ion concentration, Ions, Kejimkujik National Forest, Nova Scotia.

Soil and water sampling was carried out on seven wetlands in six sub-basins of the Kejimkujik Lake drainage basin, in Nova Scotia. The sub-basins included: Little River, Mersey River, Atkins Meadow Brook, Heber Meadows Brook, Rogers Brook and West River. One wetland was sampled within each sub-basin, with the exception of West River, in which two wetlands were sampled. Of the wetlands surveyed, three were bogs; the remaining four were classified as graminoid and shrub fens. Significant differences in the major ionic constituents occurred between wetlands classified as bogs and those classified as fens, indicating the more minerotrophic status of the fens. The fens, however, were categorized as extremely poor, being very low in pH and base cations, indicating almost no buffering capacity. This type of wetland is regarded as transitional to bog and is viewed as highly sensitive to acid deposition. Further alkalinity losses may result in abrupt changes in floral assemblages with rapid invasion of carpet forming Sphagnum species. (Mertz-PTT)
W90-05990

IMPORTANCE OF SELF-OXIDATION IN DECOMPOSITION AND ITS DEPENDENCE ON THE PH OF THE ENVIRONMENT.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
L. G. Toth, and J. Zlinszky.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 213-219, July/August 1989. 3 fig, 99 ref.

Descriptors: *Acid rain, *Hydrogen ion concentration, *Microbial degradation, *Organic matter, *Oxidation, *Physiological ecology, *Water chemistry, Acidic water, Alkaline water, Bogs, Decomposition, Enzymes, Microorganisms, Mosses, Plankton, Respiration.

The hypothesis that pH-dependent self-oxidation of dead organic matter by its own respiratory electron transport system can be an important alternative process to active decomposition by microorganisms is introduced and tested. An important event of the pH-dependent self-oxidation is the opening of cell walls and envelopes of decaying cells providing free opportunity for equilibration the internal and external pH. The electron transport system activity of homogenates of living planktonic organisms and sediments derived from alkaline Lake Balaton (Ph 8.4-8.6) and that of Sphagnum moss from an acidic peat bog (pH 3.9-4.1) showed uniform pH-dependence of respiratory enzyme system in vitro, demonstrating that there is no adaptation in enzymatic level to the pH of environment. In another set of experiments, where decaying Selenastrum capricornutum Prinz cultures were incubated in axenic conditions at pH 5.4 and pH 8.4, electron transport system activity and changes in organic carbon of the samples at low pH were minimal. At high pH a considerably high initial electron transport system activity was found which decreased exponentially in time parallel with the exponential decrease of organic carbon content of the samples. Organic carbon content of these samples stabilized five weeks after the beginning of the experiment at 19.5% of the original value. (Author's abstract)
W90-05994

INFLUENCE OF ORGANIC ACIDITY ON THE ACID-BASE CHEMISTRY OF SURFACE WATERS IN MAINE, USA.
Maine Univ., Orono. Dept. of Geological Sciences.
J. S. Kahl, S. A. Norton, R. K. MacRae, T. A. Haines, and R. B. Davis.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 221-233, July/August 1989. 3 fig, 2 tab, 64 ref. U.S. Environmental Protection Agency contract No. CR-812481-01-0.

Descriptors: *Acid lakes, *Acid rain, *Acidic water, *Anions, *Bogs, *Maine, *Organic acids, *Water chemistry, Acidity, Chemical properties, Hydrogen ion concentration, Organic carbon, Precipitation, Sulfates.

Results from surveys of low acid neutralizing capacity lakes, high elevation, and seepage lakes, and of surface waters in dystrophic, acidic bogs, indicate that acidic precipitation and organic acidity are each generally necessary, but not solely sufficient, for chronically acidic status in Maine lakes. Acidic, low dissolved organic carbon (anion concentration < 0; dissolved organic carbon < 5 mg/L) lakes of all hydrologic types are acidic due largely to acidic deposition; high dissolved organic carbon acidity, and high dissolved organic carbon drainage lakes are acidic due to a combination of both factors. No low dissolved organic carbon drainage lakes are known with pH less than about 5.0, suggesting that organic acidity is necessary to depress lake pH values to below 5 in Maine at current deposition loadings. The dominant anion of low dissolved organic carbon acidic waters is sulfate. Acidic waters with intermediate concentrations of dissolved organic carbon (5 to 30 mg/L), may be dominated by SO4 and/or organic acidity. Seepage-input lakes were the only group to include both organically-dominated (37% of the acidic lakes) and SO4-dominated members (63% of the acidic lakes). High dissolved organic carbons systems are typically low pH bogs, and are all organic acid-dominated. (Author's abstract)
W90-05995

FINNISH LAKE SURVEY: THE ROLE OF ORGANIC AND ANTHROPOGENIC ACIDITY.
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 5B.
W90-05996

SPATIAL CHARACTERIZATION OF ACIDIFICATION RELATED PARAMETERS IN SENSITIVE REGIONS OF ATLANTIC CANADA.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-06000

USE OF HISTORICAL INFORMATION FOR SELECTING A SAMPLE FROM A POPULATION OF LAKES.
National Water Research Inst., Burlington (Ontario).
A. H. El-Shaaraw, S. R. Esterby, and G. Howell.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 305-316, July/August 1989. 1 fig, 6 tab, 14 ref.

Descriptors: *Acid rain effects, *Canada, *Lakes, *Monitoring, *Statistical analysis, *Surveys, Acid rain, Acidity, History, Quebec.

In planning a monitoring strategy to quantify the present chemical status of a population of lakes in regions susceptible to the effects of acidic deposition, a decision must be made regarding the number and locations of the lakes to be monitored. Statistical methods provide the bases for making a satisfactory decision by utilizing the historical information available about the characteristics of the population of lakes. It was shown that stratification can result in increased precision of the required estimates, however, the gain was dependent on the variability of the characteristic under consideration. An approach for stratifying the population was used to investigate the spatial heterogeneity in a population of 177 lakes in Quebec, Canada. The results were then used to estimate the number of lakes required for monitoring the temporal changes in the population and to allocate the selected lakes among different strata. (Mertz-PTT)
W90-06001

DIATOM-INFERRED PH HISTORY OF KEJIMKUJIK LAKE, NOVA SCOTIA: A REINTERPRETATION.
Waterloo Univ. (Ontario). Dept. of Biology.
H. C. Duthie.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 317-322, July/August 1989. 3 fig, 19 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Canada, *Diatoms, *Hydrogen ion concentration, *Lakes, *Paleolimnology, Acidic water, Acidity, Asterionella, Color, Cores, History, Humic acids, Kejimkujik National Park, Nova Scotia, Organic matter.

A reanalysis of the diatom-inferred pH profile from a sediment core collected in 1980 from Kejimkujik Lake, in Nova Scotia, has been made in the light of improved techniques and ecological information. Using Index B calibrated for lakes in Atlantic Canada, the lake pH was 4.6 to 4.7 before anthropogenic disturbances in the watershed began around 1850. These disturbances had little immediate impact on pH, but minima of pH 4.5 were evident in the period 1916 to 1950. A diatom-inferred pH of 4.75 in the surface sediments compares with a measured pH of 4.96 in 1980. Disturbances in the watershed since around 1850 resulted in a large increase in a form of Asterionella ralfsii, a diatom associated with colored, humic water. A decline in this diatom since 1950 and an increase in taxa less typical of humic water is consistent with the hypothesis of loss of organic matter accompanying acidification from acidic precipitation. (Author's abstract)
W90-06002

EFFECTS OF ACIDITY AND DOC ON PHYTOPLANKTON COMMUNITY STRUCTURE AND PRODUCTION IN THREE ACID LAKES (NOVA SCOTIA).
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 5C.
W90-06003

COMPARISON OF THE MACROPHYTE COMMUNITIES OF A CLEARWATER AND A BROWNWATER OLIGOTROPHIC LAKE IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
C. C. Stewart, and B. Freedman.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 335-341, July/August 1989. 2 tab, 24 ref.

Descriptors: *Acid lakes, *Acid rain, *Acidic water, *Aquatic productivity, *Canada, *Macrophytes, *Oligotrophic lakes, Color, Kejimkujik National Park, Nova Scotia, Nuphar, Organic matter, Sphagnum, Transparency, Utricularia.

Beaverskin and Pebbleloggitch Lakes are small, proximate, acidic, oligotrophic, headwater lakes located in southwestern Nova Scotia. Beaverskin Lake has clear water, its euphotic zone is deep, and it has extensive beds of macrophytic vegetation that cover most of its bottom to a depth of 6.5 m. In contrast, the water of Pebbleloggitch Lake is highly colored by dissolved humic substances, and macrophytes are restricted to a narrow littoral fringe in depths of less than about 1.8 m. The most widespread macrophyte community in Beaverskin Lake occurs at depths of 2.0-6.5 m and is dominated by Sphagnum macrophyllum and Utricularia vulgaris, while the second most prominent community is littoral and is dominated by Eriocaulonh septangulare, Lobelia dortmanna, and Eleocharis acicularis. The most prominent community in Pebbleloggitch Lake is dominated by the floating-leaved Nuphar vareigatum rooted as deep as 1.8 m, while communities dominated by E. septangulare and Sphagnum spp. occur in water less than about 0.7 m deep. (Author's abstract)
W90-06004

PATTERNS OF PLANKTON SPECIES, PH AND ASSOCIATED WATER CHEMISTRY IN NOVA SCOTIA LAKES.
Newfoundland Dept. of Environment and Lands, St. John's.
A. C. Blouin.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 343-358, July/August 1989. 10 fig, 3 tab, 25 ref.

Descriptors: *Acid lakes, *Acid rain, *Canada, *Hydrogen ion concentration, *Lakes, *Phytoplankton, *Plankton, *Zooplankton, Acidity, Aquatic productivity, Chemical properties, Cluster analysis, Diatoms, Factor analysis, Nova Scotia, Physical properties, Water chemistry.

In order to assess the patterns of distribution of plankton species in relation to acidity, water chemistry, and physical characteristics, twenty lakes in Nova Scotia were selected for examination, with pH ranging from 3.5 to 7.6. Correlation and multiple regression analyses revealed associations between plankton and chemical variables. Patterns of plankton abundance and diversity were noted with respect to both pH and nutrient status, with occasionally conflicting effects of these two factors. Phytoplankton abundance was most closely associated with nutrient status, while zooplankton abundance was related to measures of primary production. The pH tended to affect plankton diversity more than abundance or standing crop. Several lakes were outliers from overall patterns, with several possible explanations. Cluster and factor analyses were used to identify associations of plankton species and to relate these associations to lake characteristics. Certain species were noted with relatively wide distribution, but which never occurred at low pH (<4.6). These were Chroococcus limneticus, Asterionella formosa, Cyclotella meneghiniana, Pinnularia braunii, and Surirella robusta for phytoplankton, and Polyphemus pediculus, Diaptomus oregonensis, and Tropocyclops prasinus for zooplankton. (Author's abstract)
W90-06005

DISTRIBUTION, ABUNDANCE AND BIOMASS OF BENTHIC MACROINVERTEBRATES RELATIVE TO PH AND NUTRIENTS IN EIGHT LAKES OF NOVA SCOTIA, CANADA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
V. A. Schell, and J. J. Kerekes.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 359-374, July/August 1989. 5 fig, 3 tab, 34 ref.

Descriptors: *Acid lakes, *Benthic fauna, *Calcium, *Canada, *Hydrogen ion concentration, *Lakes, *Macroinvertebrates, *Phosphorus, Acidity, Aquatic productivity, Clams, Leeches, Nova Scotia, Snails.

Eight lakes in Nova Scotia (Drain Lake, Little Springfield Lake, Pebbleloggitch Lake, Boarback Lake, Big Dam West Lake, Beaverskin Lake, Big Dam East Lake, and Spectacle Lake) were sampled for benthic macroinvertebrates, May-July, 1987. The lakes investigated ranged widely in pH (3.6-6.3), total phosphorus (3.3-33.1 microgram/L) and calcium (0.35-6.30 mg/L). Several macroinvertebrate groups especially Pelecypoda, Hirudinea and Gastropoda did not occur in lakes of low pH (<5.0). The bivalve Pisidium sp. occurred in one acidic lake (pH 5.2). Apparently, this was the lowest pH occurrence for Pisidium sp. at such low calcium levels (0.35 mg/L). Macroinvertebrate richness was reduced with increased levels of acidity, but nutrient availability apparently controlled macroinvertebrate abundance and biomass in the lakes. (Mertz-PTT)
W90-06006

ECOLOGICAL AND PHYSIOLOGICAL RESPONSES OF ATLANTIC SALMON IN ACIDIC ORGANIC RIVERS OF NOVA SCOTIA, CANADA.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
G. L. Lacroix.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 375-386, July/August 1989. 6 fig, 2 tab, 39 ref.

Descriptors: *Acid rain, *Acidic streams, *Aluminum, *Canada, *Ecological effects, *Fish populations, *Hydrogen ion concentration, *Salmon, *Toxicity, Acidity, Chlorine, Nova Scotia, Organic acids, Sodium, Sublethal effects, Water pollution effects.

Ecological and toxicological data from field studies on acidic rivers of Nova Scotia were examined to review the effects of low pH on Atlantic salmon (Salmo salar) populations in waters rich in organic acids where nonexchangeable forms of Al dominate at all times. There was no survival of salmon past the fry stage at pH < 4.7, and survival rates for salmon from egg to smolt only increased at pH > 4.9. Annual production of juvenile salmon and potential yield of smolts were lower at pH 4.7 to 5.4 than at pH 5.6 to 6.3 because of reduced densities attributable to the high mortality of fry at pH </= 5.0. However, acidity episodes to pH <4.7 also resulted in mortality of parr, reducing densities and often completely eliminating year-classes. The physiological responses of juvenile salmon to chronic acid conditions and to acute acidity typical of episodic events were also reviewed in relation to toxicity. Decreases in plasma Na and Cl were well correlated with ambient pH, but not with exchangeable Al concentrations in rivers. These plasma electrolytes provided reliable indicators of the thresholds for sublethal effects on ionoregulatory mechanisms. There was no morphological evidence of damage or lesions in gill epithelia, indicating that accumulation of Al in the gills of parr was not a significant factor in the lethal effects observed in acidic rivers. High organic matter content in the water apparently protected gills from adverse Al effects. Toxicity was considered to result from the effect of low ambient pH on branchial ionoregulatory mechanisms. (Author's abstract)
W90-06007

WATER CHEMISTRY AND PHYTOPLANKTON COMMUNITIES IN ACIDIC CLEAR AND BROWN-WATER LAKES IN EASTERN FINLAND.
Maj and Tor Nessling Foundation, Helsinki (Finland).
V. Ilmavirta, and P. Huttunen.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 415-432, July/August 1989. 8 fig, 3 tab, 41 ref.

Descriptors: *Acid lakes, *Acidic water, *Finland, *Phytoplankton, *Transparency, Aquatic produc-

tivity, Biomass, Cations, Chlorophyll, Color, Hydrogen ion concentration, Seasonal variation, Secchi disks, Species composition.

Water quality, phytoplankton biomass and species composition were surveyed in 9 acidic clear-water and 16 acidic humic lakes in eastern Finland. The lakes were sampled during summer stratification and autumn turnover periods. The lakes showed reasonably low variation within the two lake groups but the differences between the two groups were significant. Nutrient and base cation concentrations and color values declined with decreasing pH, but Secchi disc values increased. Phytoplankton species numbers and chlorophyll a concentrations tended to lower at low pH, but biomass and cell numbers were more or less independent of pH. The ecologically important relationship between water color and number of species may indicate the more difficult environment existing in dark water, which requires that the phytoplankton have a diversified species composition to ensure survival. On the other hand, it may also reflect the evidently more effective grazing of zooplankton on phytoplankton cells in well illuminated water. (Mertz-PTT)
W90-06010

THERMAL STRUCTURE AND CIRCULATION IN THE GREAT LAKES.
National Water Research Inst., Burlington (Ontario).
F. M. Boyce, M. A. Donelan, P. F. Hamblin, C. R. Murthy, and T. J. Simons.
Atmosphere - Ocean ATOCDA, Vol. 27, No. 4, p 607-642, December 1989. 19 fig, 146 ref.

Descriptors: *Great Lakes, *Lakes, *Thermal stratification, *Water circulation, Coriolis force, Ecosystems, International commissions, Lake morphology, Seasonal variation, Wind-driven currents.

Large enough to include many oceanic phenomena, the Laurentian Great Lakes are more accurately described as inland seas. With the exception of the shallow Western Basin of Lake Erie, the lakes are thermally stratified in summer, homogeneous in winter, with average temperatures passing through the temperature of maximum density of fresh water (4 C) in both the spring and the fall. The circulation is mainly powered by the wind but is strongly modified by thermal stratification and basin geometry. Effects of the earth's rotation are present in all large-scale flows. Current speeds are typically 10 cm/sec; they are too small, with rare exceptions, to present difficulties to navigation but a knowledge of the patterns of water movement is essential for interpreting the behavior of these valuable lakes as complex ecosystems. This paper reviews more than a century of physical study of the Great Lakes, including joint, inter-agency, and international studies of the lacustrine resources of the Great Lakes. (Author's abstract)
W90-06013

PREDICTION OF THE ABUNDANCE OF FISHES IN LAKE SYAM.
Akademiya Nauk SSSR, Petrozavodsk. Karelskii Filial.
For primary bibliographic entry see Field 5C.
W90-06014

NUMBERS, DISTRIBUTION AND CLASSIFICATION OF NITRATE REDUCING AND DENITRIFYING BACTERIA IN EMLBASE DEL RIO TERCERO, CORDOBA, ARGENTINA (RECUENTO, DISTRIBUCION Y CLASIFICACION DE BACTERIAS REDUCTORAS DE NITRATO Y DESNITRIFICANTES (EMLBASE DEL RIO TERCERO, CORDOBA, ARGENTINA)).
A. J. Marinelarena, and M. C. Alt.
Limnobios, Vol. 2, No. 10, p 717-719, December 1989. 2 fig, 12 ref. English summary.

Descriptors: *Argentina, *Bacterial analysis, *Denitrification, *Nitrogen fixing bacteria, *Reservoirs, *Sediment analysis, Classification, Distribution patterns, Enterobacteriaceae, Flavobacterium, Population density, Pseudomonas, Water sampling.

Nitrate reducing bacteria ranged from 500 to 10,000/ml in water samples and from 10,000 to 4,000,000/milliliter in sediments. Denitrifying bacteria showed numbers from 40 to 100/ml in samples of water and from 1000 to 3,000,000/milliliter in samples of sediments. Numbers of nitrate reducing bacteria were always higher than the denitrifiers and both populations in sediments were at least three orders of magnitude above those from water samples. Compared to total heterotrophic bacteria, denitrifiers were more important in sediments than in water. Representative strains were isolated and classified at the genus level. The predominant genera within both groups were Pseudomonas, Flavobacterium and Enterobacteriaceae. (Author's abstract)
W90-06029

LIFE TABLE EVALUATION OF THE EFFECTS OF CADMIUM EXPOSURE ON THE FRESHWATER CLADOCERAN, MOINA MACROCOPA.
Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-06040

SPECIATION OF PHOSPHORUS IN THE ALTENWORTH-RESERVOIR OF THE RIVER DANUBE.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
M. Sager, and R. Pucsko.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 84, No. 1, p 21-36, January 1990. 2 fig, 8 tab, 36 ref.

Descriptors: *Nutrients, *Path of pollutants, *Phosphorus, *Water chemistry, Altenwoerth Reservoir, Aluminum, Chemical analysis, Chemical interactions, Chemical reactions, Chemical speciation, Contaminated sediments, Danube River, Geochemistry, Metals, Particle size.

To estimate nutrient phosphorus deposits, availability and redissolution conditions in the Altenwoerth-Reservoir of the Danube/Lower Austria, fine sediments were repeatedly sampled from Nov. 1986 to Sept. 1987 at three sites. After wet sieving into three grain size fractions, two independent consecutive leaching techniques were applied. No significant changes of chemical and mineralogical composition occurred during the time of the investigation. The fractionation patterns depend on the grain size; the sampling site is of no influence upon the sieved samples. In the sequence dithionite/NaOH/HCl/hot NaOH, the HCl-extractable fraction is dominant, especially in coarser grains (those bound to apatite or carbonates). The rise of NaOH extractable P toward fine grain sizes means Al-bound P. Within the sequence acetate buffer/acetic acid/oxalate buffer/decomposition with hydrogen peroxide/nitric acid, the huge amounts leachable with nitric acid indicate that apatite was well; the dominating oxalate fraction at the fine grain size hints at binding in an Fe/Al/Mn-phase. The main amount of P is dialyzable as orthophosphate in the first two fractions of each sequence. No significant trend with locality and season was found. There are few connections between the amount of P and the main elements in the leaching solutions, indicating that P is not present in a stoichiometric phase. A great deal of the main elements are dissolved from other parts of the sediment. In comparison to other lake or river sediments of similar geochemical composition (termed Ca/Al/Fe-contents) the total load of N, P and organic C is of medium range. When similar procedures are applied, the P-fractionation patterns of the Danube sediments are close to those at Lake Balaton, while the sediments of most Swedish lakes, as well as Lake Piburg (Tyrol), release much more into dithionite and NaOH, possibly because the latter are higher in organic C and lower in Ca and Al. (Author's abstract)
W90-06060

CLASSIFICATION OF BACKWATERS BASED ON INVERTEBRATE COMMUNITIES AND AMPHIBIANS (ZUR TYPISIERUNG VON AUGEWASSERN ANHAND DER LITORALFAUNA (EVERTEBRATEN, AMPHIBIEN)).
Vienna Univ. (Austria). Zoologisches Inst.
V. A. Waringer-Loschenkohl, and J. Waringer.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 84, No. 1, p 73-94, January 1990. 4 fig, 4 tab, 35 ref.

Descriptors: *Amphibians, *Backwater, *Classification, *Invertebrates, *Limnology, Biological studies, Danube River, Ecosystems, Flooding, Lentic environment, Lotic environment, Macrophytes, Water circulation.

The species composition of the invertebrate and amphibian fauna in different types of backwaters is investigated. In comparing the different types of backwaters investigated, biotope diversity was highest in riverine forests which are in direct contact with the Danube river (e.g. Stopfenreuther Au). Due to flooding, the backwaters show different succession stages ranging from lotic areas close to the main river lacking vegetation, to lentic areas with a high degree of sedimentation and a high density of macrophytes. These succession stages are characterized by distinct invertebrate communities (e.g. Odonata communities). Backwaters which were cut off by the river due to regulation or impoundment installation lose their diversity--flooding is eliminated, resulting in high sedimentation rates and an increase in plant biomass in all types of waters. This situation may be improved by the flooding and intensive groundwater dynamics of tributaries as in the case of the Altenwoerther Au. The management of riverine forests by means of a supply channel (e.g. Greifensteiner Au) may also result in reduced biotope diversity. The connecting of individual backwaters creates an artificial running water system which favors certain lotic invertebrate communities while lentic communities are repressed. Flooded gravel pits may be considered valuable substitutes for backwaters if the angle of shore inclination is not too steep. (Author's abstract)
W90-06062

LIMNOLOGICAL STUDIES ON RIVER TIGRIS: SOME PHYSICAL AND CHEMICAL CHARACTERS.
Biological Research Center, Baghdad (Iraq). Dept. of Microbiology.
A. W. Sabri, B. K. Maulood, and N. E. Suliaman.
Journal of Biological Science Research (Baghdad) JBSREF, Vol. 20, No. 3, p 565-579, September 1989. 8 fig, 30 ref.

Descriptors: *Limnology, *Physical properties, *Tigris River, *Water chemistry, *Water quality, Alkalinity, Calcium carbonate, Chemical properties, Conductivity, Dissolved oxygen, Flow discharge, Hydrogen ion concentration, Transparency, Turbidity, Water temperature.

Some physical and chemical characteristics of the Tigris River were studied monthly during three successive years starting from January 1983. Samples of surface water were taken from eight stations along the stretch extending from Mosul to Baghdad. The pH values were found to be always on the alkaline side, ranging from 36 to 176 mg calcium carbonate/L. No stagnation was recorded and oxygen saturation remained above 60% through out the study period. The range of water temperature, river discharge, turbidity, conductivity and transparency were 8-30 C, 87-4180 cu m/sec, 2-430 NTU, 275-1145 microSiemens/cm and 2-245 cm, respectively. Seasonal, annual and longitudinal variation of the studied parameters were discussed. (Author's abstract)
W90-06064

STUDY OF THE PRIMARY PRODUCTIVITY IN THE SHATT AL-ARAB ESTUARY AT BASRAH, IRAQ.
Basrah Univ. (Iraq). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-06065

Group 2H—Lakes

LIMNOLOGICAL ASPECTS OF SMALL SEWAGE PONDS.
Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5D.
W90-06076

OCCURRENCE OF THERMOPHILIC CAMPYLOBACTERS IN RURAL AND URBAN SURFACE WATERS IN CENTRAL FINLAND.
National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology.
For primary bibliographic entry see Field 5B.
W90-06077

PHOSPHORUS TRANSPORT TO THE BOTTOM OF LAKE CONSTANCE.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
J. Kleiner, and H.-H. Stabel.
Aquatic Sciences AQSCEA, Vol. 51, No. 3, p 181-191, 1989. 4 fig, 3 tab, 41 ref.

Descriptors: *Lakes, *Limnology, *Nutrients, *Phosphorus, *Solute transport, Calcite, Lake Constance, Particulate matter, Sedimentation.

Despite decreasing nutrient loading of Lake Constance over the past few years, annual sedimentation rates of dry matter remained nearly constant at a level of about 1000 g/sq m/y. The phosphorus content in settling material varied between 0.13 to 0.22% of dry weight. Phosphorus was transported to the lake bottom mainly by particulate organic matter and by coprecipitation with authigenically formed calcite (estimated from results of laboratory studies). Adsorption to sinking particles of allochthonous origin was of minor importance. The effect of self-cleaning mechanism is discussed with regard to continuously declining contents of dissolved phosphorus in Lake Constance since 1981, due to external sanitation measures in the drainage area. (Author's abstract)
W90-06084

STATISTICAL MODELS FOR THE ESTIMATION OF NET PHOSPHORUS SEDIMENTATION IN LAKES.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
Y. T. Prairie.
Aquatic Sciences AQSCEA, Vol. 51, No. 3, p 192-210, 1989. 8 fig, 4 tab, 30 ref.

Descriptors: *Lakes, *Limnology, *Mathematical models, *Phosphorus, *Sedimentation, Analysis of variance, Correlation analysis, Estimating, Time series analysis.

The empirical adequacy of four phosphorus mass-balance models is evaluated with respect to how the prediction error variance of the corresponding net sedimentation parameters is propagated in the steady-state equations. Using the criterion of minimum propagation error variance (PEV), different groups of lakes can be distinguished for which different empirical equations are used to predict net phosphorus sedimentation. Application of this criterion to time-series of individual lakes shows that it is possible to determine a priori whether net annual sedimentation will be better correlated to the annual loading or to the lake content. The correlation depended also on the load/lake content ratio, suggesting that net sedimentation is best viewed as the sum of the partial sedimentation of the load and of the partial sedimentation of the lake content. On average, 25% of the load and 18% of the lake content are sedimented annually. Viewing net phosphorus sedimentation as a function of both the load and the lake content can also explain and predict the well-known cross-sectional correlation between phosphorus retention and water residence time. (Author's abstract)
W90-06085

WATER QUALITY IN RIVERS OF WESTERN SWITZERLAND: APPLICATION OF AN ADAPTABLE INDEX BASED ON BENTHIC INVERTEBRATES.
Conservation de la Faune, Saint-Sulpice (Switzerland).
For primary bibliographic entry see Field 5A.
W90-06087

ECOLOGY OF CILIATES IN RIVERWATERS: THE EVALUATION OF WATER QUALITY VIA CILIATES AND FILAMENTOUS BACTERIA.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5A.
W90-06088

LOW LEVELS OF ALUMINIUM CAUSING DEATH OF BROWN TROUT (SALMO TRUTTA FARIO, L.) IN A SWISS ALPINE LAKE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Toxicology.
For primary bibliographic entry see Field 5C.
W90-06089

GROWTH PATTERN AND MATURATION IN ARCTIC CHAR (SALVELINUS ALPINUS L.) OF LAKE WALENSTADT, SWITZERLAND.
Jagd- und Fischereiverwaltung des Kantons St. Gallen (Switzerland).
For primary bibliographic entry see Field 5G.
W90-06090

CONTROL OF PRIMARY PRODUCTIVITY AND THE SIGNIFICANCE OF PHOTOSYNTHETIC BACTERIA IN A MEROMICTIC KETTLE LAKE: MITTLERER BUCHENSEE, WEST-GERMANY.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
J. Overmann, and M. M. Tilzer.
Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 261-278, 1989. 10 fig, 2 tab, 55 ref.

Descriptors: *Limnology, *Meromictic lakes, *Photosynthetic bacteria, *Primary productivity, *West Germany, Meromixis, Mittlerer Buchensee, Oligotrophy, Plankton.

During 1986 planktonic primary production and controlling factors were investigated in a small German lake. Annual phytoplankton productivity was estimated to ca 120 g C/sq m/yr. The marked thermal stratification of the lake led to irregular vertical distributions of chlorophyll a concentrations (Chl a) and to a minor extent of photosynthesis. Between the depths of 0 to 6 m low Chl a concentrations (<7 mg/cu m)and comparatively high background light attenuation (77% of total attenuation due to gelbstoff and abioseston) was found. As a consequence, light absorption by algae was low (mean value 17.4%) and self-shading was absent. Because of the small seasonal variation of Chl a concentrations, no significant correlation between Chl a and areal photosynthesis was observed. Only in early summer (June-July) biomass appears to influence the vertical distribution of photosynthesis on a bigger scale. Around 8 m depth, low-light adapted algae and phototrophic bacteria formed dense layers. Due to low ambient irradiances, the contribution of these organisms to total primary productivity was small. Primary production and incident irradiance were significantly correlated with each other. Although the maximum assimilation number showed a clear dependence upon water temperature, the temperature was of minor importance to areal photosynthesis. (Author's abstract)
W90-06091

RELATIONSHIP BETWEEN TEXTURE AND FRACTIONS OF INORGANIC PHOSPHORUS IN THE SURFACE SEDIMENT OF A RESERVOIR.
Universidad Nacional de La Plata (Argentina). Inst. del Museo.
N. A. Gabellone, and C. Guisande.
Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 306-316, 1989. 3 fig, 3 tab, 27 ref.

Descriptors: *Limnology, *Particle size, *Phosphorus, *Reservoir sediments, Clays, Cycling nutrients, Sand, Spain.

Inorganic phosphorus was fractionated into three categories (sodium hydroxide, bicarbonate/dithionate, and hydrochloric acid-extractable) for 30 surface sediment samples in La Minilla Reservoir (Seville, Spain). The amount of reactive P extracted with sodium hydroxide (sodium hydroxide-reactive P) and with hydrochloric acid-reactive P) correlated in a multivariate regression with the clay and sand content of the sediment. This multivariate function should aid in predicting the amount of phosphorus available to the sediment organisms, and it can also contribute to the knowledge of the phosphorus budget of the reservoir. A multivariate regression of P content versus percent composition of the sediment can probably be fit adequately to many water bodies, but the coefficients will probably vary considerably. It would be interesting to determine what are the factors that affect this variation and to what extent, thus improving our knowledge of the dynamics of P in continental water bodies. (Author's abstract)
W90-06092

INVESTIGATIONS OF TROPHIC CHANGE AND INDUSTRIAL TAILINGS ACCUMULATION IN THE TRAUNSEE (AUSTRIA) USING DIATOM STRATIGRAPHY (DIATOMEENSTRATIGRAPHISCHE UNTERSUCHUNGEN ZER TROPHIEANDERUNG UND INDUSTRIESCHLAMMAKKUMULATION IM TRAUNSEE/OSTERREICH).
Institut fuer Limnologie, Mondsee (Austria).
For primary bibliographic entry see Field 5C.
W90-06093

SUBFOSSIL AND MODERN DIATOM PLANKTON AND THE PALEOLIMNOLOGY OF ROTSEE (SWITZERLAND) SINCE 1850.
Bern Univ. (Switzerland). Systematisch-Geobotanisches Inst.
A. F. Lotter.
Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 338-350, 1989. 7 fig, 1 tab, 29 ref.

Descriptors: *Diatoms, *Eutrophication, *Limnology, *Paleolimnology, *Phytoplankton, *Switzerland, Biostratigraphy, Carbonates, Rotsee.

The diatom biostratigraphy of the topmost sediment meter of Rotsee, Central Switzerland, is characterized by a major change from Cyclotella comensis-dominated to Stephanodiscus hantzschii/S. parvus-dominated assemblages. A comparison between old phytoplankton samples, taken between 1910-1930, and subfossil diatom assemblages is used for dating the upper 35 cm of the core. There is evidence that the change in dominant diatoms occurred in 1919/20, which was before the openings of an artificial inlet in 1922, and is due to increasing eutrophication. Furthermore, the sedimentary carbonate content can be used as a good indicator for past phytoplankton productivity in Rotsee. (Author's abstract)
W90-06094

ANNUAL HEAT BALANCE AND EQUILIBRIUM TEMPERATURE OF LAKE AEGERI, SWITZERLAND.
Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.
D. M. Livingston, and D. M. Imboden.
Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 351-369, 1989. 5 fig, 39 ref.

Descriptors: *Heat budget, *Lakes, *Limnology, *Mathematical equations, *Switzerland, Air temperature, Cloud cover, Heat transfer, Humidity, Seasonal variation, Temperature, Wind speed.

The mean heat budget of Lake Aegeri, Switzerland, is 950 MJ/sq m, comparable to that of neighboring lakes. The annual variation in the net heat flux can be adequately described using a six-term heat balance equation based on years of monthly mean meteorological and surface temperature data.

Although the magnitude of the net heat flux is dominated by the radiative terms of the equation, the one-month backward shift of the net flux and total heat content extrema from the solstices and equinoxes respectively is due to the phase of the non-radiative with respect to the radiative terms. A linear approximation was used to express the net heat flux in terms of a heat exchange coefficient and an equilibrium temperature. The heat exchange coefficient varies from 17 to 28 W/sq m/K in the course of a year: fluctuations in the equilibrium are found to depend mainly on fluctuations in cloud cover and relative humidity, while the effect of fluctuations in air temperature and wind speed is slight. (Author's abstract)
W90-06095

FISHES OF THE OHIO RIVER.
Louisville Univ., KY. Water Resources Lab.
For primary bibliographic entry see Field 5G.
W90-06106

BIRDS IN THE OHIO RIVER VALLEY: POSSIBLE INDICATORS OF ENVIRONMENTAL QUALITY.
Shawnee State Univ., Portsmouth, OH. Div. of Math/Science.
D. Todt.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 192-195, December 1989. 4 fig, 2 tab, 10 ref.

Descriptors: *Birds, *Ecology, *Ohio River, Species diversity.

The 1987 Boatload of Knowledge, a boatload of observant and environmentally conscious graduate students spending two weeks on the Ohio River, provided a unique opportunity to census the birds along the Ohio River from Pittsburgh to Louisville. A daily species count and determinations of species diversity on three sections of the River were done. While some difficulties were experienced during the censusing along the River, the overall results, field work plus a literature and information search, point to differences in bird species diversity along the Ohio River. The diversity of birds species corresponds to differences observed in the habitat along the sampled sections of the Ohio River. (Author's abstract)
W90-06108

LEAKY FILTERS: A WARNING TO AQUATIC ECOLOGISTS.
Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.
For primary bibliographic entry see Field 7B.
W90-06110

DIET SELECTION AND THE CONTRIBUTION OF DETRITUS TO THE DIET OF THE JUVENILE WHITE SUCKER (CATOSTOMUS COMMERSONI).
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
M. W. Ahlgren.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 41-48, January 1990. 2 fig, 4 tab, 38 ref.

Descriptors: *Detritus, *Fish behavior, *Fish diets, *Fish food organisms, *Sucker, Brine shrimp, Diets, Microcrustaceans, Organic matter.

The ash-free dry mass (AFDM) of detritus, invertebrates, and algae in the diet of juvenile white sucker was determined by quantitative microscopy. Fish were collected from a northern Michigan pond from January through October 1986 and their seasonal diet was compared with benthic invertebrate abundance. The quantity of detritus in sucker foreguts was inversely related to benthic microcrustacean densities. In July, microcrustacean densities were high and they comprised 95% of the AFCM in foregut contents. By October, microcrustacean densities had declined to 13% of their maximum density and detritus comprised over 90% of the sucker's diet AFDM. In laboratory aquaria, sucker that were fed detritus mixed with four different densities of Artemia (brine shrimp) ingested significantly more detritus from diets that provided lower Artemia densities. In the presence of high Artemia densities, sucker completely rejected detritus and ingested only Artemia. The fact that juvenile sucker can separate detritus from invertebrates that they swallow demonstrates that detritus in not ingested incidentally. Both laboratory and field data support the hypothesis that detritus is ingested intentionally when preferred invertebrate prey are scarce. (See also W90-06112) (Author's abstract)
W90-06111

NUTRITIONAL SIGNIFICANCE OF FACULTATIVE DETRITIVORY TO THE JUVENILE WHITE SUCKER (CATOSTOMUS COMMERSONI).
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
M. O. Ahlgren.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 49-54, January 1990. 3 tab, 37 ref.

Descriptors: *Detritus, *Fish diets, *Fish physiology, *White sucker, Brine shrimp, Diatoms, Diets, Feeding behavior, Fish food organisms, Growth, Organic matter.

The nutritional significance of detritus in the diet of the juvenile white sucker was evaluated by experiments designed to assess assimilation efficiency and growth of sucker fed detritus and other foods. Sucker in laboratory aquaria assimilated detritus with the following efficiencies: dry mass = 19.6%, ash-free dry mass (AFDM) = 59.7%, and total amino acids = 68.4%. Assimilation efficiencies calculated for invertebrates and natural field diets were slightly higher. Diatom assimilation was low (5.5%). In growth experiments, sucker fed detritus ad libitum lost weight, while those fed brine shrimp ad libitum grew rapidly. However, detritus increased the growth rate of sucker fed a limited invertebrate ration and reduced the rate of weight loss relative to unfed fish. The ratio of digestible protein to digestible energy calculated for natural detritus diets (3.2 mg amino acid/kJ, digestible energy) indicates that the protein content of detritus is too low to support growth. Detritus provides energy which complements limited invertebrate protein to enhance growth or reduce the rate of weight loss when invertebrate prey are not available. (See also W90-06111) (Author's abstract)
W90-06112

WOOD DYNAMICS IN COASTAL PLAIN BLACKWATER STREAMS.
Alabama Univ., University. Aquatic Biology Program.
A. C. Benke, and J. B. Wallace.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 92-99, January 1990. 3 fig, 5 tab, 31 ref. NSF Grants BSR 8406630 and BSR 8406631.

Descriptors: *Detritus, *Organic matter, *River ecology, *Swamps, *Wetlands, Decomposition, Flooding, Habitats, Logs, Ogeechee River, River flow.

The woody debris in the river swamps of the sixth order Ogeechee River and several smaller tributaries in the Coastal Plain of the southeastern USA were quantified and compared with swamp wood with woody debris in the channel, and wood movement in the swamp and main channel was studied over 20 months. Woody debris in the Ogeechee River swamps was relatively low (0.362-0.880 kg ash-free dry mass (AFDM)/sq m) in comparison to several mixed temperate deciduous forests. Similarly, wood in the tributary swamps was low (mean = 0.82 AFDM/sq m) and a fourth order tributary (2.24 kg AFDM/sq m) were significantly higher than found in their adjacent floodplains. Woody debris appeared to increase in stream channels from smaller tributaries to the sixth order river, opposite of that observed in other river systems. Tagging of logs showed that only 17% of wood in the Ogeechee channel had moved after 3 major floods, much less than in the swamps (21-84%). The abundance and stability of woody debris in the main channel allows it to be a major habitat type and source of food for both riverine invertebrates and fishes. The fate of most swamp wood appears to be decomposition and fragmentation, rather than import to the river channel. (Author's abstract)
W90-06115

CASCADING EFFECTS OF DECREASED SALINITY ON THE PLANKTON, CHEMISTRY, AND PHYSICS OF THE GREAT SALT LAKE (UTAH).
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
W. A. Wurtsbaugh, and T. S. Berry.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 100-109, January 1990. 9 fig, 45 ref.

Descriptors: *Great Salt Lake, *Limnology, *Plankton, *Saline lakes, *Utah, Brine shrimp, Chemical properties, Ecosystems, Nutrients, Predation, Rotifers, Salinity, Species diversity, Zooplankton.

Physical, chemical and biological variables were measured in the Great Salt Lake during 1985-87, when salinity in the mixolimnion was near 50 g/L, much lower than the 250 g/L maxima recorded in 1963. Decreased salinity has been accompanied by a change in macrozooplankton from one species (Artemia franciscana), to an assemblage with one rotifer, two copepods, Artemia, and the corixid Trichocorixa verticalis. Predation by the corixid may now limit Artemia to low densities (< 100/cu m). The low biomass of Artemia and other zooplankton has reduced grazing pressure on the algal community so that high chlorophyll levels (5-44 mg/cu m) and low Secchi depths (0.8-2.7 m) are now present throughout the year. The algae presently reduce soluble reactive phosphorus and inorganic nitrogen in the mixolimnion to below 5 and 50 microg/L, respectively. Shading in the 7-m thick mixolimnion by algae, and by purple-sulfur bacteria in the chemocline, decreases light penetration so that the monimolimnion now maintains a nearly constant temperature (9-11 C) throughout the year. The data support the hypothesis that the effects of corixid predation have cascaded through the Great Salt Lake, affecting herbivores, nutrients and thermal stratification. (Author's abstract)
W90-06116

ZOOPLANKTON SPECIES ASSOCIATIONS IN QUEBEC LAKES: VARIATION WITH ABIOTIC FACTORS, INCLUDING NATURAL AND ANTHROPOGENIC ACIDIFICATION.
Montreal Univ. (Quebec). Dept. of Biological Sciences.
B. Pinel-Alloul, G. Methot, G. Verreault, and Y. Vigneault.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 110-121, January 1990. 3 fig, 4 tab, 47 ref.

Descriptors: *Acid rain effects, *Lakes, *Limnology, *Quebec, *Species diversity, *Zooplankton, Acidity, Alkalinity, Hydrogen ion concentration, Lake morphology, Statistical analysis, Sulfates.

Abundances and biomass of 38 zooplankton species and accompanying abiotic data from 54 Quebec lakes were subjected to cluster and correlation analysis to determine: (1) characteristic zooplankton associations of co-occurring species; (2) relative importance of abiotic variables in lake typology; and (3) relationships between the integrated environmental factors derived from lake morphometry, water quality, and acidification level, and the structure of zooplankton communities. The eight groups of species identified in the cluster analysis may be considered separate 'species associations' characterized by distinct patterns of distribution in Quebec lakes. Differences in mean pH and sulfate concentrations can be detected between groups of lakes representing the different species associations. Factor analysis produced seven factor scores which explain 82% of the total variance of the morphological, physical, and chemical varia-

bles. The distribution pattern of acidity or alkalinity represents the major feature in water chemistry variation, but lake morphology also account for the observed environmental variability. Each factor represents an integrated environmental property correlated with a set of colinear abiotic variables. These factors are correlated with zooplankton species abundances and biomass. The community structure, whether expressed in size classes or in trophic groups, tends to vary among sets of lakes of different pH. (Author's abstract)
W90-06117

CONTRIBUTION OF RHIZOSOLENIA ERIENSIS AND CYCLOTELLA SPP. TO THE DEEP CHLOROPHYLL MAXIMUM OF SPROAT LAKE, BRITISH COLUMBIA, CANADA.
British Columbia Univ., Vancouver. Dept. of Oceanography.
L. J. Jackson, J. G. Stockner, and P. J. Harrison.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 128-135, January 1990. 8 fig, 26 ref.

Descriptors: *Chlorophyll, *Cycling nutrients, *Diatoms, *Limnology, *Phytoplankton, British Columbia, Nitrogen, Phosphorus, Seasonal variation, Spatial distribution, Sproat Lake.

Experimental fertilization of Sproat Lake British Columbia with nitrogen and phosphorus greatly increased the abundance of two centric diatoms: Cyclotella spp. and Rhizosolenia eriensis. A decrease in sinking rates to neutral buoyancy at 17.5-22.5 m an area of high nutrients and low light, coupled with sedimentation estimates of 10 million-100 million cells/sq m/d, provide strong evidence that diatoms contribute to the formation of a seasonal deep chlorophyll maximum (DCM). The position of the Sproat Lake DCM, occurring at or just above the 1% light depth, appears to be largely determined by the light regime. R. eriensis bloomed and sank out of the mixed layer early in the spring before lake fertilization began. Immediately after fertilization, concentrations of nitrate and phosphate were elevated for 1 h only in the top 1 m of the water column. Most R. eriensis cells were well below 1 m and benefited little from the nutrient addition because of temporal and spatial separation. Cyclotella spp. occurred in the upper epilimnion and bloomed later in the year and consequently benefited (by large density increases) from fertilization. It is important to consider the temporal and spatial distribution of phytoplankton in determining which species will increase in abundance as a result of areal fertilization. (Author's abstract)
W90-06118

RECYCLING OF ELEMENTS TRANSPORTED UPSTREAM BY RUNS OF PACIFIC SALMON: I. DELTA 15 N AND DELTA 13 C EVIDENCE IN SASHIN CREEK, SOUTHEASTERN ALASKA.
Alaska Univ., Fairbanks. School of Fisheries and Ocean Sciences.
T. C. Kline, J. J. Goering, O. A. Mathisen, and P. H. Poe.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 136-144, January 1990. 4 fig, 3 tab, 27 ref. NSF Grant DPP 844122285 and Alaska Sea Grant NA 86AA-D-SG041.

Descriptors: *Alaska, *Cycling nutrients, *Fish migration, *Salmon, Carbon, Nitrogen, Nutrients, Sashin Creek, Spawning, Trout.

Values of delta 15 N and delta 13 C (the per mil deviation from the recognized isotope standard) from biota of a southeastern Alaska stream (Sashin Creek) that receives an annual run of 30,000 anadromous pink salmon were measured to determine sources of nitrogen (N) and carbon (C). Marine-derived nitrogen (MDN) is the predominant source of N for food webs found in the lower 1200 m of the stream which, due to a waterfall, is the only portion of the stream available to salmon returning to spawn. Comparable spawning section biota were enriched by about 5 mil relative to the salmon-free control section, corresponding to the difference between 0 and 100% MDN in a mixing model. Food webs of resident rainbow trout, at the outlet of one of the source lakes, Sashin Lake, have very low delta 13 C, suggesting the importance of a respired C pool in the lake. The source of C in the remainder of the stream is C fixation by autochthonous producers and marine organic C (within the salmon spawning section). Resident fishes in the salmon spawning section depend on MDN and some of the C delivered by the annual run of returning salmon. (Author's abstract)
W90-06119

EFFECTS OF LARGE-SCALE METALIMNETIC MIGRATION EVENTS ON PHOSPHORUS DYNAMICS IN A NORTH-TEMPERATE RESERVOIR.
Army Engineer Waterways Experiment Station, Spring Valley, WI. Eau Galle Lab.
W. F. James, R. H. Kennedy, and R. F. Gaugush.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 156-162, January 1990. 8 fig, 27 ref.

Descriptors: *Eau Galle Reservoir, *Lake sediments, *Lake stratification, *Limnology, *Phosphorus, *Water circulation, Lake morphology, Mixing, Wind-driven currents, Wisconsin.

In Eau Galle Reservoir, Wisconsin, early in the stratified period of 1982, hypolimnetic anoxia developed, soluble reactive phosphorus concentrations increased above the profundal sediment surface, and internal total phosphorus loading was high. Shortly thereafter, the passage of a cold front with high wind power resulted in mixing and a pronounced descent of the metalimnion. During this event, previously anoxic water within the metalimnion and upper hypolimnion became reoxygenated, internal total phosphorus loading declined to a minimum, and a loss of total phosphorus mass occurred from the metalimnion and hypolimnion. Total phosphorus mass in the epilimnion remained constant during this period. A similar pattern occurred during a large, wind-driven migration of the metalimnion in early August. During such events, phosphorus sedimentation rates increased in the hypolimnion, reflecting the loss of total phosphorus mass from the water column. In contrast, other investigations of lakes have reported that phosphorus is entrained into the epilimnion during metalimnetic migrations, rather than lost through sedimentation. Phosphorus sedimentation during large metalimnetic migration events in Eau Galle Reservoir may occur because previously anoxic water containing iron becomes reoxygenated, causing the coprecipitation and sedimentation of oxidized iron and phosphorus. (Author's abstract)
W90-06120

EFFECTS OF FISH REMOVAL ON THE LIMNETIC ECOSYSTEM OF A EUTROPHIC LAKE.
Selskapet for Industriell og Teknisk Forskning, Trondheim (Norway). Div. of Applied Chemistry.
H. Reinertsen, A. Jensen, J. I. Koksvik, A. Langeland, and Y. Olsen.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 166-173, January 1990. 6 fig, 6 tab, 29 ref.

Descriptors: *Algal blooms, *Eutrophic lakes, *Fishkill, *Limnology, Chlorophyta, Cyanophyta, Daphnia, Fish, Hydrogen ion concentration, Lake Naugatiern, Norway, Phosphorus, Population density, Rotenone, Rotifers, Zooplankton.

The effects of fish elimination in the eutrophic Lake Haugatiern, Sor-Trondelag County, Norway, were studied during 1979-84. Total elimination of the fish populations by rotenone in late 1980 resulted in a four-fold decrease in the algal biomass. The species composition changed from a dominance by the large-sized Anabaena flos-aquae and Staurastrum luetkemuelleri to smaller, fast-growing species and gelatinous green algae. The total zooplankton biomass remained at the same level in all years, but while the rotifers almost disappeared after the rotenone treatment, the daphnids increased their share of the biomass from 49-63% during 1979-80 to 74-90% during 1982-84. The mean individual size of the adult daphnids increased in the same period from 1.3 to 1.8mm. A 30% drop in the total phosphorus concentration in the lake after the biomanipulation was explained by increased sedimentation of zooplankton and reduced phosphorus release from the epilimnetic sediments because of the lowered pH. The fish elimination also resulted in a lower yield of biomass per unit of phosphorus in the lake. (Author's abstract)
W90-06121

NIGHTTIME POND RESPIRATION RATE: OXYGEN OR TEMPERATURE DEPENDENT.
Hawaii Univ., Honolulu. Dept. of Zoology.
C. P. Madenjian.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 180-183, January 1990. 3 fig, 1 tab, 17 ref.

Descriptors: *Dissolved oxygen, *Diurnal variation, *Limnology, *Oxygen requirements, *Ponds, *Respiration, *Water temperature, Data interpretation, Model studies, Residual oxygen.

Two different models for the nighttime dissolved oxygen concentration (DO) dynamics in ponds were compared to determine which was more accurate. DO and water temperature were monitored overnight in marine shrimp (Penaeus vannamei and P. monodon) pond; wind speed was also measured. The Whole Pond Respiration-Diffusion (WPRD) model, in which the night respiration rate of the pond system is a function of water temperature, was fitted to observations of DO at dusk, and approximately 3 h after dusk, to generate predictions of pond DO at dawn. The Olah model, which is based on a respiration rate varying in direct proportion to DO, was also applied to the same set of DO observations to generate predictions of dawn DO. The mean absolute values of the residuals (the residual is equal to observed dawn DO minus predicted dawn DO) from applications of the WPRD and Olah models were 0.39 and 0.77 mg O2/L, respectively; the Olah model showed consistent bias. The respiration rate of the pond system at night was therefore better described as a function of water temperature than as dependent on pond DO. (Author's abstract)
W90-06122

ENVIRONMENTAL CHARACTERISTICS OF AFFLUENTS OF THE DOBCZYCE RESERVOIR (SOUTHERN POLAND) IN THE PREIMPOUNDMENT PERIOD (1983-1985): 1. SOME PHYSICO-CHEMICAL INDICES.
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
For primary bibliographic entry see Field 5B.
W90-06135

ENVIRONMENTAL CHARACTERISTICS OF AFFLUENTS OF THE DOBCZYCE RESERVOIR (SOUTHERN POLAND) IN THE PREIMPOUNDMENT PERIOD (1983-1985): 2. PERIPHYTON.
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
A. Amirowicz.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 297-304, 1989. 1 fig, 3 tab, 15 ref.

Descriptors: *Limnology, *Periphyton, *Poland, *Reservoirs, Biomass, Chlorophyll, Dobczyce Reservoir, Mineral particles, Organic matter, Seasonal variation.

The periphyton at the mouth section of the major affluents of the Dobczyce Reservoir was investigated. The mean weight of the coating formed by the periphyton was 2.5-5.7 g/sq dm, of which 2.2-5.1 g/sq dm consisted of mineral particles. The average quantity of chlorophyll-a varied from 949 to 3058 microg/sq dm. In the warm half of the year the periphyton showed smaller amounts of mineral particles, organic matter, and chlorophyll a, and greater coefficients of variation of these

parameters than in the cold half. (See also W90-06135 and W90-06137) (Author's abstract)
W90-06136

ENVIRONMENTAL CHARACTERISTICS OF AFFLUENTS OF THE DOBCZYCE RESERVOIR (SOUTHERN POLAND) IN THE PREIMPOUNDMENT PERIOD (1983-1985): 3. ICHTHYOFAUNA.

Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
M. Jelonek, and J. Starmach.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 305-316, 1989. 2 fig, 4 tab, 15 ref.

Descriptors: *Fish populations, *Limnology, *Poland, *Reservoirs, Biomass, Density, Dobczyce Reservoir, River Raba, Species composition.

The species composition, density, and biomass of fish in the River Raba and its tributaries in the area of the Dobczyce Reservoir, now under construction, were investigated. The effect of these factors on the development of a natural ichthyofauna in the future reservoir was analyzed. In the zone affected by the reservoir 23 fish species were found with numbers varying from 851-4135 individuals/ha and biomass from 6980-98,720 g/ha. Of these species 8 are adapted to life both in flowing and stagnant waters. (See also W90-06135 and W90-06136) (Author's abstract)
W90-06137

CILIATA COMMUNITIES IN THE MIDDLE SECTOR OF THE RIVER LYNA (NORTH-EASTERN POLAND) IN CONDITIONS OF NONPOINT POLLUTION INFLOW.

Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Water and Wastewater Biology.
For primary bibliographic entry see Field 5C.
W90-06139

ECOLOGICAL STUDIES ON ROTIFERA (ASCHELMINTHES) IN THE RIVER TIGRIS (IRAQ).

Biological Research Center, Baghdad (Iraq). Section of Aquatic Ecology.
A. W. Sabri.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 367-379, 1989. 5 fig, 3 tab, 22 ref.

Descriptors: *Bioindicators, *Iraq, *Rotifers, *Tigris River, *Water pollution effects, Correlation analysis, Dissolved oxygen, Nitrites, Phosphates, River flow, Species distribution, Transparency, Turbidity.

Seasonal variation of the Rotifer population in the River Tigris was observed during 1984-1985. Summer through mid-autumn was found to be the best growth period. Synchaeta stylata, an oligosaprobic organism, was quantitatively the dominant species in the Tigris. The index of similarity between stations, using Jaccard's presence-community coefficient was calculated. A dendrogram showed that the studied stretch of the river was separated into three regions in a linear arrangement. The results of a contingency table test revealed that there was a single group of Rotifera species along the 600 km stretch of the river. All species present at Station 1 were collected from all other stations downstream. It could therefore be argued that none of the activities (i.e. sewage, agriculture, and industry) along the studied area of Tigris affected the principal component of Rotifera species. Separate correlation coefficients were calculated between the environmental factors and mean number of individuals/cu dm and number of species per month. A positive significant correlation was obtained with water temperature, while a negative significant correlation was obtained with both dissolved oxygen and river discharge. The number of species was also negatively correlated with turbidity, phosphate, and nitrite during 1985, while it was positively correlated with Secchi disc readings. (Author's abstract)
W90-06140

IS FOOD AVAILABILITY THE MAIN FACTOR CONTROLLING THE ABUNDANCE OF EUCHLANIS DILATATA LUCKSIANA HAUER IN A SHALLOW, HYPERTROPHIC LAKE.

Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
J. Ejsmont-Karabin, R. D. Gulati, and J. Rooth.
Hydrobiologia HYDRB8, Vol. 186/87, p 29-34, December 1989. 2 fig, 1 tab, 21 ref.

Descriptors: *Eutrophic lakes, *Limiting factors, *Limnology, *Population dynamics, *Rotifers, Cyanophyta, Food chains, Population density, Predation.

Visual observations and experiments on food preference of Euchlanis dilatata lucksiana show that this euchlanid rotifer can feed on blue-green algae not consumed by the most planktonic animals. Nevertheless, even in lakes with blooms of blue-green algae, E. d. lucksiana occur infrequently and generally in low numbers. The causes for the rare occurrence of Euchlanis in the pelagial were explored. A comparison of threshold food concentrations calculated from N and P excretion rates with the concentrations of seston in Lake Loosdrecht shows that the seston concentrations were several times higher during the study period. This implies that the food requirements of Euchlanis were always satisfied in this lake. The time needed for the consumption of the total food fraction in a liter of lake water by a concentration of 50 Euchlanis/L was also calculated. This time varied from 70 to 200 days, so a Euchlanis population even at its maximum density will not cause major changes in blue-green algae biomass by grazing. Thus, food limitation cannot be viewed as a factor controlling the Euchlanis densities in Loosdrecht Lake. There is some evidence the Euchlanis is heavily predated in the lake, losses in its biomass accounting for 126% of the production. Adaptation of this species to the littoral zone, as expressed by the deposition of eggs on plants, can also limit the occurrence of the lucksiana form to water bodies with blooms of blue-green algae. (Author's abstract)
W90-06142

SALINITY AND TEMPERATURE INFLUENCE IN ROTIFER LIFE HISTORY CHARACTERISTICS.

Valencia Univ. (Spain). Dept. of Ecology.
M. R. Miracle, and M. Serra.
Hydrobiologia HYDRB8, Vol. 186/87, p 81-102, December 1989. 9 fig, 3 tab, 71 ref.

Descriptors: *Life history studies, *Limnology, *Rotifers, *Salinity, *Temperature effects, Aquatic habitats, Genetics, Population dynamics, Spawning.

A review of temperature and salinity effects on rotifer population dynamics is presented together with original data of these effects for three clones of Brachionus plicatilis. There is a clear relationship between temperature and the intrinsic rate of increase, r: an increase of temperature--within the natural environmental range--produces an exponential increase of r, and the slope of the response depends on the genotype. The effect of salinity is also genetically dependent; the highest r for each clone is observed at the salinity close to that of its environmental origin. The response of r to temperature is mainly a consequence of the response of the individual rates of development and reproductive timing. The effect of temperature on fecundity (number of descendants per individual life time) is negligible when temperature values are within the normal habitat ranges. On the other hand, salinity seems to affect primarily fecundity. The interaction salinity-temperature may be important in clones or species living in fluctuating environments with positive response to the more frequent combinations found in the corresponding habitats. (Author's abstract)
W90-06143

EMPIRICAL EVIDENCE FOR A COMPLEX DIURNAL MOVEMENT IN HEXARTHRA BULGARICA FROM AN OLIGOTROPHIC HIGH MOUNTAIN LAKE (LA CALDERA, SPAIN).

Granada Univ. (Spain). Dept. de Biologia Animal, Ecologia y Genetica.
P. Carrillo, L. Cruz-Pizarro, and R. Morales-Baquero.
Hydrobiologia HYDRB8, Vol. 186/87, p 103-108, December 1989. 4 fig, 12 ref.

Descriptors: *Limnology, *Mountain lakes, *Oligotrophic lakes, *Rotifers, *Spain, Diurnal variation, Light quality, Population dynamics, Spatial distribution.

Data on rotifer spatial distribution and movement of populations come, basically, from two main approaches. Diurnal vertical migration is a common phenomenon, but is variable and far less important than in crustaceans in terms of amplitude and velocity of migration. Horizontal distribution also varies and the resultant patchiness may reflect shore avoidance processes. A detailed 24 hour sampling program has been carried out at 26 depths of 6 stations located along the two main transects of lake La Caldera. The resultant data has allowed us to define for Hexarthra bulgarica a general daily trend of movement which couples a typical nocturnal vertical migration with an 'horizontal' one that is particularly conspicuous at dawn and dusk when the population seemed to move toward or away from the shore, respectively. These results suggest that light is responsible for these complex movements. Further information is needed on light intensity and angular distribution in the shore region of the lake. Subsequent studies should also consider advective factors (wind-induced water movements) in patch formation and evaluate downward movements over a sloping bottom. (Author's abstract)
W90-06144

MORPHOLOGICAL STRUCTURE AND FUNCTIONAL PATTERNS OF KERATELLA COCHLEARIS (GOSSE) POPULATIONS IN STRATIFIED LAKES.

Akademiya Navuk BSSR, Minsk. Inst. of Zoology.
G. A. Galkovskaya, and I. F. Mityanina.
Hydrobiologia HYDRB8, Vol. 186/87, p 119-128, December 1989. 6 fig, 4 tab, 20 ref.

Descriptors: *Animal morphology, *Distribution patterns, *Lake stratification, *Limnology, *Rotifers, Adaptation, Eutrophic lakes, Mesotrophic lakes, Population dynamics.

Vertical distribution of the rotifer Keratella cochlearis in stratified water columns of mesotrophic and eutrophic lakes during summer stagnation has been studied. Coexisting morphs K. cochlearis hispida (Lauterborn, 1898), K. c. tecta (Gosse, 1851) and K. c. cochlearis (Gosse, 1851) inhabit different layers in the water column and are vertically subdivided. The distribution of morph abundance and reproductive potential indicate that substitution of morphs within the vertical water column may be due to trophic conditions. The maximum population productivity is observed at the epi-metalimnion border. The maximum density zone lies below the zone of the highest productivity. Presently there are not enough data to explain morphological variability as a type of morphophysiological adaptation occurring within the limits of the genotype, nor to characterize morphs from the point of total genetic interruption as genotypes adapted to different lake conditions. If morphs are the phenotypic realization of genotypes, strict division of regions inhabited by individual morphs may be facilitated in stratified lakes. The absence of shifting condition gradients, i.e., correspondence of definite part of population to the epi-, meta-, and hypoliminion can promote selection even during successive parthenogenetic generations. The relative spatio-temporal isolation of population components may create a 'sliced functioning' of population as a whole. Optimal population productivity may be due to the formation of morphotypic-distinct functional subunits. High correlations between rotifer densities and chlorophyll concentration permit one to consider spatial morphotypic shifting as a component of a population's adaptive ability in response to variability in trophic conditions. (Author's abstract)
W90-06145

DEVELOPMENT OF HEXARTHRA SPP. IN A SHALLOW ALKALINE LAKE.
Biologische Station Neusiedler See, A-7142 Illmitz, Austria and Ludwig-Brill-Strasse 5, D-4570 Quakenbruck, West Germany.
A. Herzig, and W. Koste.
Hydrobiologia HYDRB8, Vol. 186/87, p 129-136, December 1989. 3 fig, 2 tab, 23 ref.

Descriptors: *Alkaline water, *Lakes, *Limnology, *Phenology, *Rotifers, Predation, Shallow water, Species diversity, Water chemistry.

In Neusiedler See, a shallow alkaline lake with fluctuating water level and salinity, four species of Hexarthra occur: H. mira, H. fennica, H. jenkinae (occasional) and H. polyodonta. The analysis of long-term data reveals a general phenological pattern which does not change from year to year. These rotifers first occur in May, develop a maximum in June/July, sometimes a second one in August/September and disappear in October. But the species succession is different in the various years, occasionally only one species (H. mira or H. polyodonta) being present. There is a fairly consistent relation between the chemical conditions and the prevalent species; an increase in salinity favors the development of H. polyodonta. Low temperature and wind generated suspended particles have a negative influence on the development of the Hexarthra populations. Smaller populations of Hexarthra are in a relation to the occurrence of the cladoceran Leptodora indicating predation pressure. In Neusiedler See the Hexarthra populations seem to be controlled to a great extent by abiotic factors, but predation by Leptodora and most probably by young fish seems to play an important role too. (Author's abstract)
W90-06146

HORIZONTAL DISTRIBUTION OF THE PLANKTON ROTIFERS KERATELLA COCHLEARIS (BORY DE ST VINCENT) AND POLYARTHRA VULGARIS (CARLIN) IN A SMALL EUTROPHIC LAKE.
33 Park Road, Esher, Surrey KT10 8NP, England.
A. P. Saunders-Davies.
Hydrobiologia HYDRB8, Vol. 186/87, p 153-156, December 1989. 1 fig, 1 tab, 7 ref.

Descriptors: *Distribution patterns, *Eutrophic lakes, *Limnology, *Rotifers, *Zooplankton, Correlation analysis, Environmental gradient, Light quality, Water depth.

The planktonic rotifers Keratella cochlearis and Polyarthra vulgaris were sampled at 10 cm below the surface at different distances from two dissimilar shores and in the center of a small eutrophic lake. Light and depth were measured at each sampling point. In each case the numbers of rotifers per liter increased with distance from the shore. There was a significant correlation between the numbers for the two species for the two shores, but none in the center. In the case of one shore there was a strong correlation between rotifer numbers and supra-surface ambient light. (Author's abstract)
W90-06147

COMMUNITY STRUCTURE AND COEXISTENCE OF THE ROTIFERS OF AN ARTIFICIAL CRATER LAKE.
Ghent Rijksuniversiteit (Belgium). Lab. voor Ecologie der Dieren, Zoogeografie and Natuurbehoud.
G. Bogaert, and H. J. Dumont.
Hydrobiologia HYDRB8, Vol. 186/87, p 167-179, December 1989. 7 fig, 3 tab, 21 ref.

Descriptors: *Artificial lakes, *Limnology, *Quarries, *Rotifers, *Species composition, Distribution patterns, Ecosystems, Mesotrophic lakes, Population dynamics.

The community structure and dynamics of the rotifers of an abandoned and inundated limestone quarry are described. In the site studied, quarrying ceased around 1948 and the crater-shaped cavity was allowed to fill with groundwater. The lake is mesotrophic. Zooplankton standing crop is low, but the community is rich in species. Ploesoma hudsoni and Filinia hofmanni are rare or unknown in a perimeter of several hundreds of kilometers around the lake. This illustrates that (passive) dispersal across large stretches of land even occurs in rare species. Temporal and spatial distribution, together with specific diurnal vertical movements in different seasons facilitate the coexistence of numerous species in the lake. This complex ecology contrasts with the small size of the initial propagules that helped colonize the lake. (Author's abstract)
W90-06148

ROTIFER COMMUNITIES OF ACID-STRESSED LAKES OF MAINE.
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 5C.
W90-06149

ABUNDANCE AND DIVERSITY OF PLANKTONIC ROTIFERS IN THE PO RIVER.
Ferrara Univ. (Italy). Ist. di Zoologia.
I. Ferrari, A. Farabegoli, and R. Massoni.
Hydrobiologia HYDRB8, Vol. 186/87, p 201-208, December 1989. 5 fig, 1 tab, 19 ref.

Descriptors: *Po River, *Rotifers, *Stream biota, *Zooplankton, Floods, Low flow, Population density, Species diversity.

Zooplankton samples from the middle reach of the Po River were collected daily from 17 July to 24 August 1988 from a station located near Viadana. Changes in the biocoenosis structure were analyzed in relation to variations in flow rate. Rotifers accounted for more than 99% of the total zooplankton (protozoans excluded) in every sample. The dominant species were Brachionus calyciflorus, Brachionus bennini, Brachionus budapestinensis and Epiphanes macrourus. During the summer low flow phases, the Po River waters have atrophic structure comparable to that of shallow, highly productive bodies of water. Microzooplankton are dominant, especially rotifers which attain densities that are among the highest reported. Under low water conditions zooplankton tend to become a structured community, with a stable composition, abundance and diversity in time and space. Floods have a destabilizing effect on the rotifer community, leading to a sharp increase in diversity. This increase is due to the higher number of species (benthic and phytophilous forms dislodged by the current from the bottom and vegetation), but especially to the reduction in Brachionus calyciflorus density. (Author's abstract)
W90-06150

ROTIFER DISTRIBUTION IN RELATION TO TEMPERATURE AND OXYGEN CONTENT.
Goethegasse 4, A-2380 Perchtoldsdorf, Austria.
E. Mikschi.
Hydrobiologia HYDRB8, Vol. 186/87, p 209-214, December 1989. 3 fig, 1 tab, 14 ref.

Descriptors: *Distribution patterns, *Limnology, *Oxygen requirements, *Rotifers, *Temperature effects, Mountain lakes, Seasonal variation, Species composition, Species diversity.

Lunzer Obersee, a small lake located at an altitude of 1100 m above sea level, was investigated from July 1985 to October 1987. The rotifer community consists of 7 dominant species, 7 subdominant species and 34 species which occasionally occurred in the plankton. The dominant species show rather different demands in relation to temperature and oxygen content; e.g.: Filinia hofmanni was found at a wide range of oxygen concentrations (0.6-13.3 mg O2/L) and low temperatures (4-6 degrees C), living in the upper water layers (1-7 m) during spring and in the deeper, anoxic zone in summer. In contrast, Asplanchna priodonta was found at rather high oxygen contents (>9 mg O2/L), and showed a wide range of temperature tolerance (4-15 degrees C). According to their requirements, three different groups of animals can be distinguished: (A) Cold stenothermous species tolerating a wide range of oxygen contents (i.e. Filinia hofmanni and Keratella hiemalis); (B) species tolerating a wide range of temperatures but requiring high oxygen content (i.e. Synchaeta pectinata, Polyarthra dolichoptera and Asplanchna priodonta); and (C) species showing great tolerance in relation to temperature and oxygen content (i.e. Ascomorpha ecaudis and Keratella cochlearis). (Author's abstract)
W90-06151

PATTERNS IN THE COMPOSITION OF THE ROTIFER COMMUNITIES FROM HIGH MOUNTAIN LAKES AND PONDS IN SIERRA NEVADA (SPAIN).
Granada Univ. (Spain). Dept. de Biologia Animal, Ecologia y Genetica.
R. Morales-Baquero, L. Cruz-Pizarro, and P. Carrillo.
Hydrobiologia HYDRB8, Vol. 186/87, p 215-221, December 1989. 5 fig, 1 tab, 19 ref.

Descriptors: *Limnology, *Mountain lakes, *Rotifers, *Spain, *Species composition, Conductivity, Distribution patterns, Ponds, Species diversity.

On the basis of periodic collections of rotifers from 29 lakes and ponds over 2500 m above sea level in the Sierra Nevada (Southern Spain), patterns of species richness, distribution and community composition were evaluated. Results allow us to distinguish communities which fall into two major lake types. One is defined by the presence of typically planktonic species as well as lower specific richness whereas the other includes communities of mainly benthic and periphytic species. Both lake types seem to be related to small differences in their physical and chemical characteristics. In earlier studies, changes in pH were related to changes in the structure of rotifer communities in Newfoundland and Adirondack Mountain lakes. In the Sierra Nevada, however, this factor was not clearly related to rotifer assemblages. Another important factor in the overall structure of rotifer communities is mineralization. The finding that low conductivity lakes yielded greater densities of typically planktonic species, whereas high conductivity lakes contained predominantly benthic and periphytic species, suggests that this change is associated with the development of littoral vegetation in these small alpine lakes. (Author's abstract)
W90-06152

PERCENTAGE OF ROTIFERS IN SPRING ZOOPLANKTON IN LAKES OF DIFFERENT TROPHY.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
S. Radwan, and B. Popiolek.
Hydrobiologia HYDRB8, Vol. 186/87, p 235-238, December 1989. 1 fig, 1 tab, 15 ref.

Descriptors: *Lakes, *Limnology, *Rotifers, *Trophic level, *Zooplankton, Eutrophication, Poland, Seasonal variation, Waterfleas.

Studies carried out on 8 lakes in the Leczna-Wlodawa Lakeland of eastern Poland indicated that the qualitative and quantitative structure of zooplankton was clearly correlated with the lake trophic state. In the spring zooplankton of lakes affected by gradual natural eutrophication were dominated by rotifers. In the zooplankton of lakes strongly affected by human activities, Cladocera dominated. With an increase in lake trophy there was in increase in the number of species that were indicators of eutrophy and a decrease in the number of indicators of mesotrophy. The total number of species in individual lakes tended to increase with an increase in trophy. (Author's abstract)
W90-06153

TASMANIA REVISITED: ROTIFER COMMUNITIES AND HABITAT HETEROGENEITY.
Murray-Darling Freshwater Research Centre, Albury (Australia).
R. J. Shiel, W. Koste, and L. W. Tan.
Hydrobiologia HYDRB8, Vol. 186/87, p 239-245, December 1989. 4 fig, 1 tab, 12 ref.

Descriptors: *Aquatic habitats, *Lakes, *Limnology, *Rotifers, *Tasmania, Acidic water, Heterogeneity, Microenvironment, Species diversity.

The results of four field surveys for Rotifera in Tasmania are summarized. Most new species and records in a 1987 survey were from acid waters (pH <4.0) of dune lakes on the west coast (42 degrees South). Marked intra- and interhabitat differences in rotifer communities of lakes and ponds were demonstrated by cluster analysis and related to habitat heterogeneity. Many thousands of years isolation during periods of climatic change could account for the high species diversity and predominance of taxa now recorded primarily in the tropics, but which may have persisted in Tasmanian waters as relict populations from a time when Tasmania's climate, and that of southern Australia, was tropical. Two broad rotifer assemblages were found. In the west were 11 of the 13 endemic taxa and most of the species which have not been recorded from the mainland. Waters are dark-black humic acid type, low in electrolytes, and presumably differ markedly in characteristics such as nutrients and phytoplankton, and rotifer composition from those to the east, which is a rainshadow area. Here, waters are less humic, some are alkaline, and electrolytes are higher, including some saline and hypersaline waters on the east coast, i.e. they reflect geological and climatic differences between the two areas. The heterogeneity of rotifer assemblages across the island appears to be a response to local, even microhabitat, variations in their requirements. (Author's abstract)
W90-06154

OCCURRENCE OF ROTIFERA IN THE FIELD UNDER NATURAL AND INTENTIONALLY-CHANGED CONDITIONS: II. LAKE NUMASAWA.
Nihon Univ., Tokyo. Biological Lab.
For primary bibliographic entry see Field 5C.
W90-06155

BRACHIONUS PLICATILIS TOLERANCE TO LOW OXYGEN CONCENTRATIONS.
Valencia Univ. (Spain). Dept. of Ecology.
A. Esparcia, M. R. Miracle, and M. Serra.
Hydrobiologia HYDRB8, Vol. 186/87, p 331-337, December 1989. 2 fig, 1 tab, 23 ref.

Descriptors: *Limnology, *Oxygen depletion, *Oxygen requirements, *Population dynamics, *Rotifers, Animal growth, Metabolism, Saline lakes, Tolerance.

Tolerance to low oxygen concentrations is expected in Brachionus plicatilis, a rotifer adapted to live in saline warm waters. The population dynamics of a clone of this species, isolated from an endorreic saline lake, was studied under controlled laboratory conditions. Although their growth and metabolism is extremely reduced, B. plicatilis populations are able to maintain relatively high-density populations (a mean of 35 individuals/ml) in oxygen concentrations below 1 mg/L, for more than one month. A decrease in metabolic rate seems to be the main feature induced by low oxygen availability, as has been observed in other invertebrates. Because oxygen depletion slows down growth and thus increases the survival time of the population, it could function as a regulating mechanism. In one of the studied cases in which the density of Brachionus plicatilis reached high values, the population died off immediately after the period of uncontrolled growth. This species also seems to be capable of activating fermentative metabolic pathways thus reducing the oxygen requirements but also reducing the energetic efficiency. (Author's abstract)
W90-06156

DECOMPOSITION STUDIES ON TWO FLOATING LEAVED MACROPHYTES, NYMPHAEA NOUCHALI AND NYMPHOIDES INDICA, OF LAKE KONDAKARLA, INDIA.
Andhra Univ., Waltair (India). Dept. of Botany.
K. S. N. Murty, and V. Seshavatharam.
Proceedings of the Indian Academy of Sciences (Plant Sciences) PIPLDS, Vol. 99, No. 5, p 473-483, October 1989. 2 fig, 5 tab, 26 ref.

Descriptors: *Decomposing organic matter, *Floating plants, *India, *Lakes, *Limnology, Aquatic plants, Leaves, Nutrients, Roots.

Rates of weight loss and nutrient release (N, P, Ca, Mg, Na, K) were measured in decomposing tissues of Nymphaea nouchali (leaf and rhizome) and Nymphoides indica under field (90 days) and laboratory (60 days) conditions. Dry weight loss followed the sequence of Nymphoides indica>Nymphaea nouchali leaf>Nymphaea nouchali rhizome. The rate of nutrient release (N, P, Ca, Mg) from the decomposing tissues of Nymphaea nouchali rhizome appears to be correlated with nutrient concentration in leachate (receiving water) under laboratory experiments. The concentration of nitrogen in the decomposing tissues of all the samples increased with time. No increase in sodium and potassium concentrations was observed during the study under both the conditions. The maximum elemental loss was greater in laboratory experiments than in the field studies. Accumulation of nitrogen, calcium and magnesium instead of release at certain stages of decomposition is attributed to microbial immobilization. The sequence of elemental loss in the decomposing tissues of these macrophytes is Na>K>P>Mg>Ca>N. (Author's abstract)
W90-06158

FISH COMMUNITIES IN LAKES IN SUBREGION 2B (UPPER PENINSULA OF MICHIGAN) IN RELATION TO LAKE ACIDITY. VOLUME I.
Northrop Services, Inc., Corvallis, OR.
R. F. Cusimano, J. P. Baker, W. J. Warren-Hicks, V. Lesser, and W. W. Taylor.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-161830. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/3-89/021a, March 1989. 114p, 18 fig, 36 tab, 67 ref.

Descriptors: *Acid rain effects, *Fish populations, *Lake acidification, *Limnology, *Michigan, Acid neutralizing capacity, Aluminum, Calcium, Darters, Fish, Hydrogen ion concentration, Minnow, Organic carbon, Silica, Species diversity.

Surveys of fish community status were conducted in summer of 1987 in 49 lakes in Subregion 2B, the Upper Peninsula of Michigan, as part of the Phase II of the Eastern Lake Survey. Lake selection involved a variable probability sampling design. Fish communities were surveyed using gill nets, trap nets, beach seines, and angling. Duplicate surveys were conducted for 10 of the 49 lakes as part of the quality assurance/quality control protocol. Fish were collected in 47 of the 49 lakes surveyed. Extrapolation of the results to the Eastern Lake Survey Phase II target population suggests that 99.4% of the lakes in the area support fish. For the 49 survey lakes, the number of fish species caught per lake (species richness) was lower in seepage lakes (without inlets or outlets) than in non-seepage lakes and was also lower in lakes with lower pH, acid neutralizing capacity (ANC), calcium (and other base cations), dissolved oxygen content (DOC) and silica and with higher levels of extractable aluminum. For several fish species and for cyprinid (minnow) and darter species as a group, lakes without fish had significantly lower levels of pH, ANC, calcium, base cations, silica, and sulfate; were smaller in size; and were more often seepage lakes than non-seepage lakes. In contrast to the large number of variables associated with fish presence/absence and species richness, variations in the numbers of fish caught and catch per unit effort among lakes appeared to be independent of lake characteristics. (See also W90-06215) (Author's abstract)
W90-06181

NATIONAL BENTHIC SURVEILLANCE PROJECT: PACIFIC COAST. PART I: SUMMARY AND OVERVIEW OF THE RESULTS FOR CYCLES I TO III (1984-86).
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 5B.
W90-06197

NATIONAL BENTHIC SURVEILLANCE PROJECT: PACIFIC COAST. PART II: TECHNICAL PRESENTATION OF THE RESULTS FOR CYCLES I TO III (1984-86).
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 5B.
W90-06198

UPDATE OF THE CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS (FY 89).
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 6G.
W90-06203

FISH COMMUNITIES IN LAKES IN SUBREGION 2B (UPPER PENINSULA OF MICHIGAN) IN RELATION TO LAKE ACIDITY. VOLUME II: APPENDICES.
Northrop Services, Inc., Corvallis, OR.
For primary bibliographic entry see Field 5B.
W90-06215

WATER QUALITY OF THE LEXINGTON RESERVOIR, SANTA CLARA COUNTY, CALIFORNIA, 1978-80.
Geological Survey, Sacramento, CA. Water Resources Div.
R. T. Iwatsubo, M. A. Sylvester, and I. S. Gloege.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4253, Nov. 1988. 64p, 13 fig, 12 tab, 20 ref.

Descriptors: *Lake classification, *Lexington Reservoir, *Mesotrophy, *Primary productivity, *Thermal stratification, *Water quality, Algae, Bacteria, Beneficial use, California, Los Gatos Creek, Santa Clara County, Trace elements.

Analysis of water samples from Lexington Reservoir and Los Gatos Creek upstream from the reservoir from June 1978 through September 1980 showed that water generally met water-quality objectives identified by California Regional Water Quality Control Board, San Francisco Bay Region. Water-temperature profiles show that Lexington Reservoir is a warm monomictic lake. During summer, dissolved-oxygen concentrations generally were not reduced below 5.0 mg/L in the hypolimnion; only once during the study did bottom waters become anoxic. Water transparency decreased with depth. The euphotic zone ranged from 1.0 to 5.4 m, depending on suspended solids and algae, and was greater in summer than in spring. Calcium and bicarbonate were dominant ions at all stations except during spring, following the rainy season, when waters were a mixed cation bicarbonate type. Nitrogen concentrations were greater in samples from reservoir stations than in those from Los Gatos Creek, with most of the nitrogen in ammonia and organic forms. The amount of dissolved nitrate appeared to be related to phytoplankton abundance. Phosphorus and trace-element concentrations were low at all stations. Estimates of net primary productivity and Carlson's trophic-state index, based on chlorophyll-a concentrations, indicated that reservoir classification ranges from oligotrophic to mesotrophic. Blue-green algae generally were predominant in reservoir samples. (USGS)
W90-06221

RECONNAISSANCE OF WATER QUALITY OF PUEBLO RESERVOIR, COLORADO--MAY THROUGH DECEMBER 1985.
Geological Survey, Denver, CO. Water Resources Div.
P. Edelmann.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4118, 1989. 53p, 1 pl, 21 fig, 4 tab, 40 ref. Project CO198.

Group 2H—Lakes

Descriptors: *Colorado, *Limnology, *Nutrients, *Reservoirs, *Trace elements, *Water quality, Dissolved solids, Phytoplankton, Pueblo Reservoir.

Pueblo Reservoir is the farthest upstream, mainstream reservoir constructed on the Arkansas River and is located in Pueblo County approximately 6 miles upstream from the city of Pueblo, Colorado. During the 1985 sampling period, the reservoir was stratified, and underflow from the Arkansas River occurred that resulted in stratification with respect to specific conductance. Concentrations of dissolved solids decreased markedly below the thermocline during June. Later in the summer, dissolved-solids concentrations increased substantially below the thermocline. Substantial depletion of dissolved oxygen occurred near the bottom of the reservoir. The dissolved oxygen minimum of 0.1 mg/L occurred during August near the reservoir bottom at transect 7 (near the dam). The average total-inorganic-nitrogen concentration near the reservoir surface was about 0.2 mg/L; near the reservoir bottom, the average concentration was about 0.3 mg/L. Concentrations of total phosphorus ranged from less than 0.01 to 0.05 mg/L near the reservoir surface, and from less than 0.01 to 0.22 mg/L near the reservoir bottom. At transect 2 (about 7 miles upstream from the dam) near the bottom of the reservoir, concentrations of total iron exceeded aquatic-life standards, and dissolved-manganese concentrations exceeded standards for public water supply. Diatoms, green algae, blue-green algae, and cryptomonads comprised the majority of phytoplankton in Pueblo Reservoir in 1985. The maximum average of 41,000 cells/ml occurred in July. Blue-green algae dominated from June to September; diatoms were the dominant group of algae in October. The average concentrations of phytoplankton decreased from July to October. (USGS)
W90-06232

TREND ANALYSIS OF LAKE PARKER STAGE AND RELATION TO VARIOUS HYDROLOGIC FACTORS, 1950-86, LAKELAND, FLORIDA.
Geological Survey, Tampa, FL.
S. E. Henderson, and M. A. Lopez.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4037, 1989. 27p, 9 fig, 6 tab, 8 ref.

Descriptors: *Lake stages, *Statistical analysis, *Water level, Pumpage, Regression analysis.

Kendall tau test and regression analysis were used to determine if statistically significant long-term trends exist for Lake Parker, Florida stage data or for four other area lakes, four groundwater sites, four rainfall sites, Lakeland public-supply pumpage, and pan evaporation. A 10% significance level was used for criterion of an existing trend. Findings were consistent between the two analytical methods. There were no long-term trends indicated for seasonal or annual stage data at Lake Parker. Statistically significant Kendall tau slope estimators were detected for pan evaporation (+0.45 in/yr), Lakeland well-field pumpage (+0.56 million gal/day/yr), and one groundwater site (+0.48 ft/year). Decreasing trends were indicated for three other lakes (-0.03 to -0.27 ft/year) and one groundwater site (-0.25 ft/year). Kendall tau tests of four annual rainfall records indicated no long-term trends. Change in Lake Parker stage from November to May was related by multiple linear regression to change in groundwater level, rainfall, and pumpage for the same time period. The regression coefficient of determination was 0.90, and the standard error was 0.24 ft. Monthly change in lake stage for November through May was related to evaporation, rainfall, and groundwater levels with a coefficient of determination of 0.67 and a standard error of 0.14 ft. (USGS)
W90-06259

2I. Water In Plants

NATURAL SELECTION AND GENETIC ADAPTATION TO HYPERSALINITY IN JUNCUS ROEMERIANUS SCHELLE.
Gulf Coast Research Lab., Ocean Springs, MS. Botany Section.
For primary bibliographic entry see Field 2L.
W90-05896

LITTER PRODUCTION IN A MANGROVE STAND OF THE SAUDI ARABIAN RED SEA COAST.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Faculty of Marine Science.
For primary bibliographic entry see Field 2L.
W90-05898

IMPACTS OF FORESTS ON WATER CHEMISTRY.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
For primary bibliographic entry see Field 2K.
W90-05983

VEGETATION, SOILS, AND ION TRANSFER THROUGH THE FOREST CANOPY IN TWO NOVA SCOTIA LAKE BASINS.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
For primary bibliographic entry see Field 2K.
W90-05984

HEAT SHOCK PROTEIN EXPRESSION IN THERMOTOLERANT AND THERMOSENSITIVE LINES OF COTTON.
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
For primary bibliographic entry see Field 3F.
W90-06253

2J. Erosion and Sedimentation

RUNOFF COEFFICIENT AND SEDIMENT YIELD IN SMALL WATERSHEDS UNDER LAND-USE CHANGES IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Dept. of Soil and Water Conservation.
For primary bibliographic entry see Field 2E.
W90-05636

USE OF THE RATIONAL FORMULA IN INFILTRATING MOUNTAINOUS CATCHMENTS.
Sultan Qaboos Univ., Muscat (Oman). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05647

STOCHASTIC MODELS IN HYDROMORPHOLOGY.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
For primary bibliographic entry see Field 2E.
W90-05652

NONLINEAR RESISTANCE RELATIONSHIPS FOR ALLUVIAL CHANNELS.
Interstate Commission on the Potomac River Basin, Rockville, MD.
For primary bibliographic entry see Field 8B.
W90-05665

FLUVIAL HYDRODYNAMIC AND SEDIMENT TRANSPORT MODEL FOR THE CHESAPEAKE BAY WATERSHED.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
Z. Hosseinipour.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 792-801, 4 fig, 1 tab, 12 ref.

Descriptors: *Chesapeake Bay, *Estuaries, *Sediment transport, *Hydraulics, *Channel flow, Open-channel flow, Watersheds, Model studies, Mathematical studies, Sediment yield, Erosion, Monocacy River, Maryland, Rivers, Water quality, St Venant equation, Flow velocity, Hydraulic radius.

A one-dimensional hydrodynamics and sediment transport model for rivers and estuaries was developed. It used the Saint Venant equations for fluid flow and sediment yield and sediment continuity equations for particulate transport. The Four Point Implicit numerical scheme was adopted for the time iteration. The Newton-Raphson iterative technique was used to treat nonlinearity. The flow equations were solved simultaneously for velocity and discharge at all cross sections. From these parameters, flow depth, channel width, and hydraulic radius were calculated to be used for the computation of bed shear velocity and velocity for incipient motion. These variables and the particle fall velocity were then used in the Yang equation (total load formula) for finding the sediment flux at a given cross section. The sediment flux was then used in the sediment continuity equation with lateral sediment inflow to calculate the sediment cross-sectional change. Scour and deposition was then calculated. Preliminary testing of the model on the Monocacy River, Maryland, produced promising results. (See also W90-05621) (Cassar-PTT)
W90-05705

FORECAST OF STABILITY OF BED LOAD IN UNSTABLE CHANNELS.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
Y. L. Peich, and Y. V. Pissarev.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 802-806, 1 fig.

Descriptors: *Sediment transport, *Bed load, *Streambeds, *River beds, *Viscosity, *Water pollution effects, Model studies, Mathematical studies, Particle size, Particulate matter.

The concept of a characteristic (critical) fall diameter for bed load particles is introduced. It was determined that the inertial force of the particle is proportional to the square of the characteristic fall diameter. This relationship was used to forecast the effect of liquid viscosity changes on the bed load stability in polluted waters. In the case of bed load particles with large fall diameters, the bed load mobility increase in relation to an increase in liquid viscosity is insignificant. For small fall diameters an increase in liquid viscosity corresponds to an increase in the bed load mobility coefficient. Therefore, water contamination which causes an increase in water viscosity results in the increase in the non-scouring velocity of the flow within the entire range of the Reynolds numbers. This results in an increase in river bed resistance to scouring. (See also W90-05621) (Cassar-PTT)
W90-05706

NUMERICAL SIMULATION OF TRANSIENT SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
J. C. Yang, and J. Y. Wang.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 807-816, 3 fig, 1 tab, 14 ref.

Descriptors: *Sediment transport, *Channel morphology, *Land use, *Channels, *Alluvial channels, Simulation analysis, Model studies, Mathematical studies.

A model based on the uncoupling technique but incorporating the coupling relation between the sediment discharge and the bed level was proposed. This partially coupled model proved simpler and required less computation time than the coupled model. The partially coupled model performed as well as the coupled model in the simula-

tion of transient uniform sediment transport. The numerical oscillation phenomena occurring with use of the uncoupled model was reduced with use of the partially uncoupled model. (See also W90-05621) (Cassar-PTT)
W90-05707

COMPARISON OF SUSPENSATE AND BOTTOM STREAM SEDIMENT GEOCHEMISTRY AT A PB OCCURRENCE IN THE SHENANDOAH VALLEY ZN DISTRICT, NORTHWEST VIRGINIA.
George Washington Univ., Washington, DC. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W90-05856

MINERALIZATION OF CHITIN IN THE SEDIMENTS OF THE YTHAN ESTUARY, ABERDEENSHIRE, SCOTLAND.
Aberdeen Univ. (Scotland). Dept. of Genetics and Microbiology.
For primary bibliographic entry see Field 2L.
W90-05911

SAMPLER FOR THE WATER-SEDIMENT INTERFASE (MUESTREADOR PARA LA INTERFASE AGUA-SEDIMENTO).
For primary bibliographic entry see Field 7B.
W90-06028

INTERACTIONS BETWEEN ARSENIC AND IRON OXYHYDROXIDES IN LACUSTRINE SEDIMENTS.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W90-06057

RELATIONSHIP BETWEEN TEXTURE AND FRACTIONS OF INORGANIC PHOSPHORUS IN THE SURFACE SEDIMENT OF A RESERVOIR.
Universidad Nacional de La Plata (Argentina). Inst. del Museo.
For primary bibliographic entry see Field 2H.
W90-06092

INVESTIGATIONS OF TROPHIC CHANGE AND INDUSTRIAL TAILINGS ACCUMULATION IN THE TRAUNSEE (AUSTRIA) USING DIATOM STRATIGRAPHY (DIATOMEEN-STRATIGRAPHISCHE UNTERSUCHUNGEN ZER TROPHIEANDERUNG UND INDUSTRIESCHLAMMAKKUMULATION IM TRAUNSEE/OSTERREICH).
Institut fuer Limnologie, Mondsee (Austria).
For primary bibliographic entry see Field 5C.
W90-06093

PHYSICAL PRINCIPLES OF SEDIMENTOLOGY: A READABLE TEXTBOOK FOR BEGINNERS AND EXPERTS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Geologisches Inst.
K. J. Hsu.
Springer-Verlag, New York, New York. 1989. 233 p.

Descriptors: *Geophysics, *Sedimentology, Evaporation, Geohydrology, Groundwater movement, Hydraulics, Oceans, Particle size, Sedimentation, Thermodynamics.

This is a textbook devoted to the physics of sedimentological processes. The applicability of fundamental principles, such as Newton's Three Laws of Motion, the Law of Conservation of Energy, the First and Second Laws of Thermodynamics, and of other physical relations in hydraulics and groundwater hydrology is illustrated by discussions of natural processes which form sediments or sedimentary rocks. The 14 chapters include such topics as: (1) mineral classification; (2) grains; (3) sediment transport; (4) gravity; (5) suspension and currents; (6) sand wave migration; (7) ocean currents; (8) groundwater movement; (9) evaporation; (10) isotope fractions; and (11) basin subsidence. An appendix includes equations showing the quantitative relations in the physical principles of sedimentology. (Lantz-PTT)
W90-06186

SEDIMENTOLOGY AND PETROLEUM GEOLOGY.
Oslo Univ. (Norway). Dept. of Geology.
K. Bjorlykke.
Springer-Verlag, New York, New York. 1989. 363 p.

Descriptors: *Geology, *Petrology, *Sedimentology, Alluvial deposits, Deltas, Geochemistry, Glacial sediments, Hydrologic budget, Lake sediments, Logging (Recording), Model studies, Sediment transport, Sedimentation, Sediments, Stratigraphy, Well logs.

In this introduction to sedimentology and petroleum geology the subjects, which are closely related but mostly treated separately, are integrated. The first part covers the basic aspects of sedimentology, sedimentary geochemistry and diagenesis, including brief discussions of flow in rivers and channels, types of sediment transport, lake and river deposits, deltas (river-dominated, tide-dominated, and wave-dominated) and the water budget. Principles of stratigraphy, seismic stratigraphy and basin modeling form the basis for the last part on petroleum geology. Here subjects include the composition of kerogen and hydrocarbons, theories of migration and trapping of hydrocarbons and properties of reservoir rocks. Finally, short introductions to well logging and production geology are given. (Lantz-PTT)
W90-06187

CONTAMINATED SEDIMENTS: LECTURES ON ENVIRONMENTAL ASPECTS OF PARTICLE-ASSOCIATED CHEMICALS IN AQUATIC SYSTEMS.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W90-06189

SUSPENDED SEDIMENT AND SEDIMENT-SOURCE AREAS IN THE FOUNTAIN CREEK DRAINAGE BASIN UPSTREAM FROM WIDEFIELD, SOUTHEASTERN COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
P. von Guerard.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4136, 1989. 36p, 13 fig, 11 tab, 23 ref. Project CO196.

Descriptors: *Land use, *Sediment yield, *Suspended load, *Urban hydrology, Bank erosion, Suspended-sediment concentration.

Suspended-sediment samples were collected from synoptic-sampling sites to determine suspended-sediment concentrations, loads, yields, and sediment-source areas in the Fountain Creek drainage basin upstream from Widefield, Colorado. Suspended-sediment yields ranged from 0.004 to 278 tons/sq mi/day. Twenty-four sites were sampled that represent urban and rural land use. The median suspended-sediment yield from urban drainage basins was 7.7 tons/sq mi/day and the median suspended-sediment yield from rural drainage basins was 0.46 ton/sq mi/day. Sediment-transport equations were derived for total suspended-sediment discharge and suspended-sand discharge at seven periodic-sampling sites. Annual suspended-sediment loads and yields were computed for the 1985 water year. Urbanization in the downstream parts of the Monument Creek drainage basin, the main tributary to Fountain Creek, affected sediment loads. The downstream 14% of the Monument Creek drainage basin contributed about 61% of the annual suspended-sediment load transported at the mouth of Monument Creek. About 73% of the annual suspended-sediment load for Fountain Creek at Colorado Springs was contributed by Monument Creek. Abandoned mill tailings along Fountain Creek contributed little to total suspended sediment load. Contributions of streambank erosion to basin sediment yields were not quantified. However, the measured rate of streambank erosion at a site on Fountain Creek has increased during a 37-year period. (USGS)
W90-06233

2K. Chemical Processes

PALYGORSKITE-SEPIOLITE.
Geological Survey, Reston, VA. Water Resources Div.
B. F. Jones, and E. Galan.
IN: Hydrous Phyllosilicates (Exclusive of Micas). Mineralogical Society of America. Reviews in Mineralogy, Volume 18, September 1988. 44p, 20fig, 8 tab, 207 ref.

Descriptors: *Palygorskite, *Sepiolite, *Minerals, *Geohydrology, Hydrogen ion concentration, Soil water, Sediment chemistry, Salinity, Aquifer characteristics, Alkalinity, Clays.

Palygorskite and sepiolite clays are rare in nature, but they have been used by man for centuries because of their many diverse and useful properties. At present, the two most important deposits of these minerals are in the Meigs-Attapulgus-Quincy district, Georgia and Florida for palygorskite, and in Vallecas-Vicalvaro, Madrid (Spain) for sepiolite. Palygorskite predominates in pedogenic calcretes and aquifer cements where the interstitial solution is recharged by dilute waters which never accumulate as much solute, even on evaporative concentration as do basin sinks. Sepiolite in calcrete apparently forms only when reactive (probably largely colloidal) alumina is unavailable; it appears in association with closed basin solutions and sediments only when solute alkali is too low to form smectite and pH levels are not extremely alkaline. Its formation may be inhibited by the pre-existence of simple phyllosilicate or other sheet structures, as with waters with high sediment content or sediments with insufficient pore site. However, its water-accomodating structure is more suitable to direct precipitation from solution. Previous studies indicate that palygorskite formation in the marginal marine environment required less than normal salinity, as well as somewhat elevated levels of solute silica. In lacustrine closed basins or marginal continental basins transitional to marine, the occurrence of palygorskite indeed appears to indicate brackish water, and the presence of sepiolite reflects both salinity increases and the lack of abundant surficial sediment inflow. (Lantz-PTT)
W90-05748

GROUND-WATER-QUALITY ASSESSMENT OF THE CENTRAL OKLAHOMA AQUIFER, OKLAHOMA--ANALYSIS OF AVAILABLE WATER-QUALITY DATA THROUGH 1987.
For primary bibliographic entry see Field 5B.
W90-05749

EVALUATION AND ANALYSIS OF THREE DYNAMIC WATERSHED ACIDIFICATION CODES (MAGIC, ETD, AND ILWAS).
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5C.
W90-05790

CHESAPEAKE BAY EARTH SCIENCE STUDY: INTERSTITIAL WATER CHEMISTRY--CHEMICAL ZONATION, TRIBUTARIES STUDY AND TRACE METALS.
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 2L.
W90-05808

ALUMINIUM DIS-EQUILIBRIUM SOLUBILITY CONTROLS IN SCOTTISH ACIDIC CATCHMENTS.
Macaulay Land Use Research Inst., Aberdeen (Scotland).
For primary bibliographic entry see Field 5B.

W90-05836

VARIABILITY OF PHOSPHORUS FORMS IN SUSPENDED SOLIDS AT THE LAKE ERIE-GRAND RIVER CONFLUENCE.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
T. Mayer, and P. G. Manning.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 687-699, 1989. 9 fig, 2 tab, 36 ref.

Descriptors: *Chemical properties, *Grand River, *Iron, *Lake Erie, *Phosphorus, *Sediment chemistry, Aluminum, Bioavailable phosphorus, Carbon, Lake sediments, Manganese, Suspended solids.

The forms of phosphorus and iron have been determined in suspended solids collected from within and off the Grand River estuary, Lake Erie, in August and October of 1985. Concentrations of organic and inorganic carbon, aluminum, and manganese were also measured. These chemical parameters were then used to assess the importance of processes such as input of stream solids, biological productivity, shoreline erosion, and lake sediment resuspension in regulating suspended solids composition in the studied area. Considerable spatial and temporal variation was found in the distribution of the measured parameters. Both total and bioavailable P (BAP) in suspended solids were higher in the summer than in the fall, BAP accounting for about 34.5% of total P in August and about 17.5% in October. The BAP distribution is consistent with the distribution of ferric ion, whereas apatite-P follows the distribution of aluminum and ferrous ion in chlorite and other clay minerals. The concentration of BAP is generally higher in the near-surface solids and increases with increasing distance from the river mouth. The seasonal and spatial trend in total P, BAP, organic carbon, and ferric ion concentrations reveal that a large proportion of particulate P is associated with particles of biogenic origin, rather than inorganically bound to Fe oxides. The apatite-P, Al, and ferrous ion concentrations reveal the importance of sediment resuspension processes, within the distance of approximately 4 km, particularly in the fall. The same parameters point to loss of terrigennous material of riverine origin and from the shoreline erosion within the short distance from the river mouth. (Author's abstract)
W90-05853

COMPARISON OF SUSPENSATE AND BOTTOM STREAM SEDIMENT GEOCHEMISTRY AT A PB OCCURRENCE IN THE SHENANDOAH VALLEY ZN DISTRICT, NORTHWEST VIRGINIA.
George Washington Univ., Washington, DC. Dept. of Geology.
F. R. Siegel.
Southeastern Geology SOGEAY, Vol. 30, No. 3, p 203-215, December 1989. 6 fig, 1 tab, 9 ref.

Descriptors: *Geochemical prospecting, *Sediment chemistry, *Virginia, *Zinc, Extraction techniques, Geochemistry, Heavy metals, Sediment identification, Sediment transport, Shenandoah Valley, Suspended solids.

Suspended sediment was collected from stream water together with equivalent active sediment from the stream bottom at 42 sites near the Gordon Lead property, Shenandoah County, Virginia (USA) to test the relative effectiveness of suspended and bottom sediment in the geochemical exploration for stratabound Mississippi Valley type ores. Zn was a pathfinder to the mineralization, and Zn in the suspensates gave a larger number of strong anomalies, higher in magnitude, than Zn in the -100 mesh size of the bottom sediment, either as total Zn or as Zn extracted with cold 3% HCl. Pb was detected only in the cold acid extraction. In combination with cold acid extracted Zn and Cu, Pb formed a multielement anomaly that located the Gordon property mineralization and had a longer downstream dispersion than did the suspensate or total dissolution multielement anomalies. Groundwater inflow or spring discharge from the mineralized host rock into the stream may influence the development of and locations of the anomalies. Both suspensates and cold acid extracted samples are more effective for geochemical prospecting in this area than the total dissolution samples of the -100 mesh size of the active stream sediments. (Author's abstract)
W90-05856

TRENDS IN PARTICULATE DEPOSITION AND PRECIPITATION CHEMISTRY AT LEEDS (U.K.) 1907-1987.
Leeds Univ. (England). Dept. of Fuel and Energy.
For primary bibliographic entry see Field 5B.
W90-05900

RAINWATER COMPOSITION IN ATHENS, GREECE.
Athens Univ. (Greece). Lab. of Climatology.
For primary bibliographic entry see Field 5B.
W90-05901

INFLUENCE OF ATMOSPHERIC TRANSPORT ON PRECIPITATION CHEMISTRY AT TWO SITES IN THE MIDWESTERN UNITED STATES.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-05902

CHARACTERISTIC TIME TO ACHIEVE INTERFACIAL PHASE EQUILIBRIUM IN CLOUD DROPS.
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5B.
W90-05904

CHEMICAL COMPOSITION OF COASTAL STRATUS CLOUDS: DEPENDENCE ON DROPLET SIZE AND DISTANCE FROM THE COAST.
California Inst. of Tech., Pasadena. W.M. Keck Lab. of Environmental Engineering Science.
J. W. Munger, J. Collett, B. Daube, and M. R. Hoffmann.
Atmospheric Environment ATENBP, Vol. 23, No. 10, p 2305-2320, October 1989. 14 fig, 6 tab, 37 ref. California Air Resources Board Contract A4-142-32.

Descriptors: *Acid rain, *Aerosols, *Air pollution, *Atmospheric water, *Cloud chemistry, *Cloud liquid water, *Clouds, *Fog, *Path of pollutants, California, Chemical composition, Coasts, Fluid drops, Ions, Marine climates, Sulfates.

Coastal stratus clouds are a major feature of the Los Angeles weather pattern, and a correlation has been noted between episodes of high sulfate concentrations and the presence of clouds or fog. The aerosol at elevated sites in the South Coast Air Basin in California is a mixture of sea salt and pollution-derived secondary aerosol. The influence of sea salt declines with increasing distance from the coast. Nitric acid appears to react with the sodium chloride in sea salt aerosol to release gaseous hydrogen chloride and form sodium nitrate in the aerosol. At inland sites, aerosol concentrations differ during periods of onshore and offshore flow. The highest concentrations were observed during the day when the onshore flow transported pollutants to the sites, while lower concentrations were observed at night when drainage flows from nearby mountains influenced the sites. Variations in liquid water content are a major influence on cloudwater ion concentrations. Comparisons of the ionic concentration in two size-segregated fractions of cloudwater collected during several sampling intervals suggest that there is a large difference between the average composition of the smaller droplets and that of the larger droplets. Concentrations of sodium, calcium and magnesium ions in the large droplet fraction were observed to be higher than in the small-droplet fraction, while the concentrations of sulfate, nitrate, ammonium and hydrogen ions were higher in the small-droplet fraction. Chloride concentrations were nearly equal in both fractions. Differences in the composition of size-fractionated cloudwater samples suggest that large droplets are formed on sea salt and soil dust, which are large aerosol, and small droplets are formed on small secondary aerosol composed primarily of ammonium sulfate, and ammonium nitrate. The concentration of several components that exist partly in the gas phase (e.g. chloride), formic acid and acetic acid) appear to be independent of droplet size. (Author's abstract)
W90-05905

HUMIC AND OTHER NEGATIVELY CHARGED COLLOIDS OF IRON AND COPPER IN RIVER WATER.
Nagoya Univ. (Japan). Faculty of Engineering.
M. Hiraide, T. Ueda, and A. Mizuike.
Analytica Chimica Acta ACACAM, Vol. 227, No. 2, p 421-424, December 15, 1989. 2 fig, 1 tab, 11 ref.

Descriptors: *Copper, *Heavy metals, *Humic substances, *Ion exchange, *Iron, *Pollutant identification, *Water chemistry, Anions, Colloids, Membrane filters, Metal complexes, Particle size, Resins, Rivers, Separation techniques, Sorption.

Iron and copper present as humic and other negatively charged colloids were studied by sorption on indium-treated XAD-2 resin and DEAE-Sephadex A-25 anion exchanger and by Nuclepore membrane filtration. Nuclepore polycarbonate etched-track membrane filters were used for size fractionation because they have individual channels of uniform diameter. Reagent humic acid and fulvic acid at low milligrams/L levels passed completely through a 0.015 micron filter. Sorption on the filters of metal cations, humic complexes and hydrated iron (III) oxide colloids was negligible. The predominant iron species was colloidal particles consisting of hydrated iron (III) oxide and clay covered with humic substances. Hydrated iron (III) oxide-clay particles are found abundantly in river water by x-ray microanalysis. Negatively charged inorganic colloids containing iron, which exist in lesser amounts in river water, include hydrated iron (III) oxide-clay and hydrated iron (III)-hydrated silica aggregates which are dominant below 0.1 microns. In contrast, humic colloids of copper were mostly smaller than 0.015 microns in diameter and provided nearly all the negatively charged species of copper, suggesting that most of copper-humic complexes were not associated with iron-containing colloidal particles. Chemical species other than humic colloids and other negatively charged species include cations and neutral inorganic complexes for copper and positively charged inorganic colloids for iron. (Geiger-PTT)
W90-05937

OXYGEN ISOTOPIC VARIATION OF FALLING SNOW PARTICLES WITH TIME DURING THE LIFETIME OF A CONVECTIVE CLOUD: OBSERVATION AND MODELLING.
Nagoya Univ. (Japan). Water Research Inst.
A. Sugimoto, and K. Higuchi.
Tellus TELLAL, Vol. 41B, No. 5, p 511-523, November 1989. 9 fig, 2 tab, 17 ref.

Descriptors: *Clouds, *Oxygen, *Snow, *Stable isotopes, Chemistry of precipitation, Convection, Model studies, Precipitation intensity, Radar.

The delta O18 (per mille deviation from Standard Mean Ocean Water) of falling snow particles was observed at two stations 8 km apart along the trajectory of a convective cloud. The comparison of the difference in delta O18 between the two stations with radar observation reveals the following: (1) the delta O18 values of snow from a convective cloud decrease with time during its lifetime; the rate of decrease observed in 7 cases of convective radar echoes was 0.2 ppt to 3.1 ppt during 15 min of movement of radar echoes between two stations, and was large during and after its maximum precipitation intensity; and (2) the rate of decrease was large in cells in which precipitation intensity was large in the windward area. A one-dimensional time-dependent model is used to calculate the isotopic variation of falling snow

during the lifetime of a convective cloud cell. The calculated results explain the observed results well. In addition, calculated results show that the rate of decrease of delta O18 is large in cells with high precipitation efficiency, and in cells with large terminal velocity of precipitating particles. (Author's abstract)
W90-05975

PRECIPITATION CHEMISTRY IN NOVA SCOTIA: 1978-1987.
Nova Scotia Dept. of the Environment, Halifax.
For primary bibliographic entry see Field 5B.
W90-05978

ESTIMATION OF ATMOSPHERIC DEPOSITION INPUT OF SULPHUR AND NITROGEN OXIDES TO THE KEJIMKUJIK WATERSHED: 1979-1987.
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W90-05979

METEOROLOGICAL CHARACTERISTICS OF LARGE ACIDIC DEPOSITION EVENTS AT KEJIMKUJIK, NOVA SCOTIA.
Atmospheric Environment Service, Bedford (Nova Scotia).
For primary bibliographic entry see Field 2B.
W90-05980

SOURCES OF ACIDITY IN FOREST-FLOOR PERCOLATE FROM A MAPLE-BIRCH ECOSYSTEM.
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 5B.
W90-05982

IMPACTS OF FORESTS ON WATER CHEMISTRY.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
M. K. Mahendrappa.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 61-72, July/August 1989. 1 fig, 5 tab, 47 ref.

Descriptors: *Chemistry of precipitation, *Acid rain, *Rainfall, *Canada, *Soil water, *Forest soils, *Forest hydrology, *Deciduous forests, *Stemflow, *Throughfall, Water chemistry, Acidity, Acid water, Hydrologic cycle, Ecological effects, New Brunswick.

Forest canopies and soil organic horizons have been identified as two major components of forest ecosystems interacting with and altering the chemistry of rainwater. Data, collected over a 13-year period from different softwood and hardwood stands located in central New Brunswick, are presented to demonstrate differences among stands in their ability to alter the chemistry of rainwater. In both the canopies and the soil organic horizons, retention and exchange processes are effective in altering the chemistry of rainwater. Significant species effects are recognized in the partitioning of rainwater into throughfall, stemflow, and interception, and in altering of its chemistry. Stemflow components generally contribute to acidity, while throughfall reduces acidity of rainwater. Some of the chemical characteristics of rainwater reaching the forest floor are shown to be similar to those of streams associated with the forest stands. The data show significant species effects on the moisture retention characteristics of the organic materials accumulated under each stand, which in turn affect the residence time of the acid components of rain. Admittedly, before entering streams and lakes associated, the composition of the liquid leaving the organic horizons is further altered by mineral soils. (Author's abstract)
W90-05983

VEGETATION, SOILS, AND ION TRANSFER THROUGH THE FOREST CANOPY IN TWO NOVA SCOTIA LAKE BASINS.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
K. E. Percy.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 73-86, July/August 1989. 1 fig, 4 tab, 27 ref.

Descriptors: *Acid rain, *Canada, *Chemistry of precipitation, *Coniferous forests, *Deciduous forests, *Lakes, *Throughfall, *Vegetation effects, Cations, Hydrogen ion concentration, Ions, Kejimkujik National Park, Nitrates, Nova Scotia, Organic soils, Soil profiles, Sulfates, Water chemistry.

Characterization of the forest vegetation and soils in two adjacent, contrasting headwater lake basins located in Kejimkujik National Park, Nova Scotia was completed in 1980. Precipitation chemistry was studied during May to November, 1981-83 at two forested plots in each basin. There were 2012 stems/ha in Beaverskin basin and 1816 stems/ha in Pebbleloggitch basin. Beaverskin species composition was predominantly coniferous (72% of stems), while Pebbleloggitch was predominantly deciduous (52% of stems). Thickness and mass of organic soil layers were greater in Beaverskin. Mineral soil cation concentrations were similar. There were no differences between the basins in mean incident bulk precipitation pH. Mean volume-weighted pH for the period (73 collections) was 4.80. Sixteen percent of collections had a pH < 4.25. Sulfate deposition in incident bulk precipitation (May to November) ranged from 5.4-8.5 kg/ha during 1981-83, while NO3(-) ranged from 0.04-0.93 kg/ha. The partitioning of incident precipitation into throughfall varied considerably (69-38%) year-to-year. Temporal flux of ions did not differ significantly. Amounts of all major ions in throughfall especially SO4(-2) and base cations (Ca(+2) + Mg(+2) + K(+) + Na(+)) were enriched. (Author's abstract)
W90-05984

SEASONAL VARIATIONS OF WATER CHEMISTRY IN OLIGOTROPHIC STREAMS AND RIVERS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
J. Kerekes, and B. Freedman.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 131-144, July/August 1989. 8 fig, 2 tab, 20 ref.

Descriptors: *Acid rain, *Acid streams, *Canada, *Chemical properties, *Seasonal variation, *Streamflow, Acidity, Alkalinity, Anions, Calcium, Chlorine, Color, Hydrogen ion concentration, Kejimkujik National Park, Magnesium, Nova Scotia, Sodium, Sulfates.

The seasonal patterns of flow and the concentrations of color, Mg, Ca, H(+), Na, Cl, organic anions, SO4, and Gran alkalinity were examined for five streams or rivers in Kejimkujik National Park (Lower Mersey River, Atkins Brook, Grafton Brook, Pebbleloggitch Brook, and Beaverskin Brook). These range in organic color and acidity from very dark-water Atkins Brook (average 191 Hazen units, Ph 4.2) to clearwater Beaverskin Brook (5 Hazen units, Ph 5.5). In general, most dissolved substances were present in relatively large concentration during the high-flow period of winter-spring (most notably color, Mg, H(+), Ca, Na, organic anions, and SO4). In contrast, Gran alkalinity generally occurs in its highest concentration during the low-flow period. These observations suggest that during the high-flow period substances were flushed from the terrestrial watersheds of these rivers and streams. (Author's abstract)
W90-05986

ALUMINUM SPECIES IN POREWATERS OF KEJIMKUJIK AND MOUNTAIN LAKES, NOVA SCOTIA.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-05988

SEASONAL PATTERNS OF MINERAL AND ORGANIC ACIDIFICATION IN TWO STREAMS IN SOUTHWESTERN NOVA SCOTIA.
Inland Waters Directorate, Moncton (New Brunswick). Water Quality Branch.
For primary bibliographic entry see Field 2E.
W90-05989

CHEMICAL CHARACTERIZATION OF SEVERAL WETLANDS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Canadian Wildlife Service, Hull (Quebec). Sustainable Development Branch.
For primary bibliographic entry see Field 2H.
W90-05990

FRACTIONAL PRECIPITATION OF HUMIC ACID FROM COLORED NATURAL WATERS.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 7B.
W90-05991

ACID-BASE ANALYSIS OF DISSOLVED ORGANIC MATTER IN SURFACE WATERS.
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
For primary bibliographic entry see Field 7B.
W90-05992

CHEMICAL AND MICROBIAL DIAGENSIS OF HUMIC MATTER IN FRESHWATERS.
McMaster Univ., Hamilton (Ontario).
T. A. Clair, F. Barlocher, P. Brassard, and J. R. Kramer.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 205-211, July/August 1989. 2 fig, 1 tab, 10 ref.

Descriptors: *Acid rain, *Canada, *Chemical properties, *Humic acids, *Hydrogen ion concentration, *Microbial degradation, *Organic matter, *Water chemistry, Acidic water, Brown water, Kejimkujik National Park, Kinetics, Neutralization, Nova Scotia.

The importance of microbial activity in changing the chemical properties of humic material in brown waters was measured as a function of pH, acid neutralization capacity, and pKa affinity spectrum from brownwater samples kept in aquaria and sterile flasks. (Waters and sediments were collected from Moose Pit Brook, located near Kejimkujik National Park, Nova Scotia.) Changes to the humic matter in nonsterile microcosms caused increases in pH and acid neutralization capacity and loss of strong organic acid pKa sites. Microbial activity was shown to be the main contributor to a decrease in acidity of humic material as samples kept under sterile conditions showed less change than nonsterile ones. Microbial processes were shown to be mostly due to sessile organisms on the walls of the aquaria and in sediments. The data suggest that acid-base properties of brownwaters can be modified based on residence times, as well as by temperature in their basins. Assuming similar starting humic materials, microbial degradation may account for the lower acidity measured in lakes and large rivers, compared to headwaters. (Author's abstract)
W90-05993

IMPORTANCE OF SELF-OXIDATION IN DECOMPOSITION AND ITS DEPENDENCE ON THE PH OF THE ENVIRONMENT.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 2H.
W90-05994

INFLUENCE OF ORGANIC ACIDITY ON THE ACID-BASE CHEMISTRY OF SURFACE WATERS IN MAINE, USA.
Maine Univ., Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2H.

W90-05995

FINNISH LAKE SURVEY: THE ROLE OF ORGANIC AND ANTHROPOGENIC ACIDITY.
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 5B.
W90-05996

RAIN PROJECT: ROLE OF ORGANIC ACIDS IN MODERATING PH CHANGE FOLLOWING REDUCTION IN ACID DEPOSITION.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5B.
W90-05997

OCCURRENCE OF KRYPTON AND XENON IN THE BAKRESWAR THERMAL SPRING GASES.
Variable Energy Cyclotron Centre, Calcutta (India). Helium Recovery Lab.
D. Ghose, S. K. Das, and S. D. Chatterjee.
Naturwissenschaften NATWAY, Vol. 76, No. 11, p 520-521, November 1989. 1 tab, 4 ref.

Descriptors: *Krypton, *Soil gases, *Thermal springs, *Xenon, Groundwater, Temperature, Earth pressure, Radioactivity.

The abundance of noble gases present in the emissions from the Bakreswar thermal springs were analyzed and compared to noble gas levels present in atmospheric air. The ratio of krypton to xenon obtained is very similar to that derived from fissionogenic materials. The pressures and high temperatures present in the earth's mantle may enable these noble gases to combine with highly electronegative elements to form clathrate compounds. Thus the terrestrial noble gases may contain both a primordial component and a component arising from their secondary production through nuclear processes. The natural outflow of these could connote the presence of higher concentrations of radioactive minerals embedded within groundwater below the thermal spring waters. (Brunone-PTT)
W90-06022

NUMBERS, DISTRIBUTION AND CLASSIFICATION OF NITRATE REDUCING AND DENITRIFYING BACTERIA IN EMLBASE DEL RIO TERCERO, CORDOBA, ARGENTINA (RECUENTO, DISTRIBUCION Y CLASIFICACION DE BACTERIAS REDUCTORAS DE NITRATO Y DESNITRIFICANTES (EMLBASE DEL RIO TERCERO, CORDOBA, ARGENTINA)).
For primary bibliographic entry see Field 2H.
W90-06029

GOLD SPECIATION IN NATURAL WATERS: I. SOLUBILITY AND HYDROLYSIS REACTIONS OF GOLD IN AQUEOUS SOLUTION.
McGill Univ., Montreal (Quebec). Dept. of Geological Science.
D. Vlassopoulos, and S. A. Wood.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 1, p 3-12, January 1990. 6 fig, 2 tab, 59 ref, append.

Descriptors: *Chemical speciation, *Geochemistry, *Gold, *Metal complexes, *Thermodynamics, *Water chemistry, Hydrolysis, Inorganic compounds, Natural waters, Sodium hydroxide, Solubility, Solute transport.

Geochemical modeling of the dissolution, transport, and precipitation of gold in the hydrosphere requires knowledge of the stoichiometries and thermodynamic stabilities of gold species in aqueous solution. The solubility of metallic gold (Au) and the thermodynamics of formation of hydrolyzed aqueous species of Au(I) are examined. Solubility measurements of crystalline Au in dilute to concentrated sodium hydroxide (NaOH) solutions at 25 C have been carried out. The data were fitted to a general half reaction of gold with water to produce AuO2Hx anions and H(+) in order to identify the stoichiometry and stability of the hydrolyzed species formed. The monohydroxide, AuOH(H2O) is the most stable inorganic Au species up to about pH 12. The equilibrium constant for the formation of this species is log K sub 1 = negative 22.57 +/-0.44. Consideration of competitive complexation of Au by a number of inorganic ligands which may occur in natural waters indicates that AuOH(H2O) is the most stable inorganic Au species over a wide range of Eh, pH, and ligand activities. The only inorganic ligands which may occur in natural waters at concentrations high enough to stabilize Au(I) include hydrogen monosulfide ion (HS(-)) under reducing conditions, S2O3(--) under alkaline oxidizing conditions, chloride ion (Cl(-)) in very acidic, oxidizing brines, and possibly cyanide (CN(-)) locally, in environments where there is biogenic and/or anthropogenic production of cyanide. Calculated equilibrium pe-pH diagrams for Cl(-) and the Epsilon S activities typical of both fresh and seawater show that gold hydroxide hydrate (AuOH(H2O)) is probably the dominant dissolved Au species in these environments, with the exception of anoxic ocean and lake waters. (Author's abstract)
W90-06055

INTERSTITIAL WATER CHEMISTRY OF PU239,240 AND AM241 IN THE SEDIMENTS OF THE NORTH-EAST IRISH SEA.
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Directorate of Fisheries Research.
For primary bibliographic entry see Field 5B.
W90-06056

INTERACTIONS BETWEEN ARSENIC AND IRON OXYHYDROXIDES IN LACUSTRINE SEDIMENTS.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W90-06057

SR87/SR86 VALUES OF CANADIAN SHIELD BRINES AND FRACTURE MINERALS WITH APPLICATIONS TO GROUNDWATER MIXING, FRACTURE HISTORY, AND GEOCHRONOLOGY.
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-06058

SPECIATION OF PHOSPHORUS IN THE ALTENWORTH-RESERVOIR OF THE RIVER DANUBE.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
For primary bibliographic entry see Field 2H.
W90-06060

EVALUATION OF THE SPECIATION OF INORGANIC CONSTITUENTS IN SEDIMENTS OF THE RESERVOIR AT ALTENWORTH OF THE RIVER DANUBE.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
For primary bibliographic entry see Field 5B.
W90-06061

BRINES EXPELLED ALONG THE MAIN THRUSTS OF THE WESTERN ALPS (MIGRATION DES SAUMURES AU FRONT DES CHEVAUCHEMENTS DE L'ARC ALPIN OCCIDENTAL).
Montpellier-2 Univ. (France). Lab. de Geologie Structurale Appliquee.
F. Arthaud, and J. Dazy.
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 309, No. 14, p 1425-1430, November 1989. 2 fig, 10 ref.

Descriptors: *Alps, *Brines, *Geochemistry, *Geohydrology, *Mineral water, *Tectonics, Chlorides, Groundwater, Halite, Meteoric water, Water pollution sources.

In the Alps, the presence of chloride ions in salt waters was commonly considered to be the result of leaching of Triassic evaporites. Evaporitic sequences of Triassic age are widely spread in the Alps; however, within the Alps, evidence of halite is very scarce. It is highly probable that most Triassic halite was leached and scattered into the Mesozoic sedimentary sequence, before thrusting started. There is geochemical and isotopic evidence that the mineralization of salt springs in the Western Alps resulted from mixing, in various proportions, of two types of water: (1) recent meteoric water, and (2) old deep-seated brines. This explanation is supported by a model of the circulation of fluids governed by tectonic evolutions. (Author's abstract)
W90-06063

PHOSPHORUS TRANSPORT TO THE BOTTOM OF LAKE CONSTANCE.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
For primary bibliographic entry see Field 2H.
W90-06084

STATISTICAL MODELS FOR THE ESTIMATION OF NET PHOSPHORUS SEDIMENTATION IN LAKES.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
For primary bibliographic entry see Field 2H.
W90-06085

RELATIONSHIP BETWEEN TEXTURE AND FRACTIONS OF INORGANIC PHOSPHORUS IN THE SURFACE SEDIMENT OF A RESERVOIR.
Universidad Nacional de La Plata (Argentina). Inst. del Museo.
For primary bibliographic entry see Field 2H.
W90-06092

DOMINATING INFLUENCE OF NH3 ON THE OXIDATION OF AQUEOUS SO2: THE COUPLING OF NH3 AND SO2 IN ATMOSPHERIC WATER.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
P. Behra, L. Sigg, and W. Stumm.
Atmospheric Environment ATENBP, Vol. 23, No. 12, p 2691-2707, December 1989.

Descriptors: *Acid rain, *Ammonia, *Chemistry of precipitation, *Ozone, *Sulfur dioxide, Aerosols, Alkalinity, Buffer capacity, Fog, Hydrogen ion concentration, Model studies, Oxidation, Temporal variation.

The oxidation of sulfur dioxide in atmospheric water (cloud, rain, liquid aerosol and fog) is influenced by the presence of ammonia. The enhancing effect of ammonia is especially pronounced if the oxidation occurs with an oxidant such as ozone for which the reaction rate increases strongly with increasing pH, because ammonia: (1) codetermines the pH of the water and thus in turn the solubility of sulfur dioxide; and (2) provides acid neutralizing capacity as well as buffer intensity to the heterogeneous atmosphere-water system in counteracting the acidity produced by the oxidation of sulfur dioxide. At low buffer intensity, the acidity production leads to the alleviation of further sulfur dioxide oxidation. A computer model is used to assess the influence of sulfur dioxide, ammonia and other potential acids and bases, of aerosols and of the liquid water content on the composition and its temporal variation of closed or open atmospheric systems as a consequence of sulfur dioxide oxidation by ozone. An essential corollary to this model is a definition of atmospheric alkalinity (or acidity). Model results are compared with field data obtained in measuring the temporal variation in urban/rural fog composition. (Author's abstract)
W90-06096

IMPACT OF SOIL-DERIVED AEROSOLS ON PRECIPITATION ACIDITY, IN INDIA.
Meteorological Office, Poona (India).

G. S. Varma.
Atmospheric Environment ATENBP, Vol. 23, No. 12, p 2723-2728, 1989. 6 fig, 1 tab, 20 ref.

Descriptors: *Acid rain, *India, *Particulate matter, *Soil chemistry, Acidity, Alkalinity, Hydrogen ion concentration, Mapping, Soil-derived aerosols.

An attempt has been made to study the impact of soil-derived aerosols on the rain acidification using the data of high volume samplers set up at different parts of the country by the India Meteorological Department and National Environmental Engineering Research Institute. Suspended particulate matter exhibits significant positive correlation with rain pH indicating its alkaline behavior. The more such particulates are present in the atmosphere, the more alkalinity will appear in the rainwater. It has been found statistically that the rainfall pH is a function of soil pH. Thus the rainwater at a particular place possesses all the fundamental characteristics of the nearby soil. The rainfall weighted pH values of the last 11 years at 10 Indian stations have therefore been used along with the pH values as determined by various other workers in different parts of the country and on that basis, iso-pH curves have been drawn and finally the pH regionalization has been determined. On the basis of this study the entire country can be divided into four zones as follows: (1) highly sensitive pH zone; (2) moderately sensitive pH zone; (3) normal pH zone; and (4) high pH zone. The pH regionalization of India on the basis of the results obtained in the present study is of utmost importance. It is especially of concern for developing countries like India where large industries are very frequently set up in different parts of the country without any prior knowledge of the sensitivity of the region to acid rain, because in the past no such zones were prepared for the country. Acid zoning maps should be prepared by each country because acid rain has now become an international problem, not confined to the boundaries of one country alone. (Author's abstract)
W90-06097

LOCALLY GENERATED ATMOSPHERIC TRACE METAL POLLUTION IN CANADIAN ARCTIC AS REFLECTED BY CHEMISTRY OF SNOWPACK SAMPLES FROM THE MACKENZIE DELTA REGION.
Arctic Labs. Ltd., Sidney (British Columbia).
For primary bibliographic entry see Field 5B.
W90-06098

PRINCIPAL COMPONENT ANALYSIS OF SO4(2-) PRECIPITATION CONCENTRATIONS OVER THE EASTERN UNITED STATES.
Environmental Protection Agency, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.
For primary bibliographic entry see Field 5B.
W90-06099

TRACE METAL AND MAJOR ION COMPOSITION OF PRECIPITATION AT A NORTH SEA COASTAL SITE.
Marine Lab., Aberdeen (Scotland).
For primary bibliographic entry see Field 5B.
W90-06100

HEALTH AND ENVIRONMENTAL CHEMISTRY: ANALYTICAL TECHNIQUES, DATA MANAGEMENT, AND QUALITY ASSURANCE.
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5A.
W90-06190

DISTRIBUTION AND VARIABILITY OF PRECIPITATION CHEMISTRY IN THE CONTERMINOUS UNITED STATES, JANUARY THROUGH DECEMBER 1983.
Geological Survey, Portland, OR. Water Resources Div.
J. F. Rinella, and T. L. Miller.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-132663/AS. Price codes: A12 in paper copy, A02 in microfiche. USGS Open-File Report 87-558, 1988. 241p, 17 fig, 10 tab, 21 ref, 3 append.

Descriptors: *Acid rain, *Chemistry of precipitation, *Pollutant identification, *Water analysis, Analytical techniques, Areal precipitation, Chemical analysis, Ions, Precipitation, United States, Water pollution sources, Water quality.

Analysis of atmospheric precipitation samples, collected during the 1983 calendar year from 109 National Trends Network sites in the United States, are presented in this report. The sites were grouped into six geographical regions based on the chemical composition of the samples. Precipitation chemistry in these regions was influenced by proximity to (1) oceans, (2) major industrial and fossil-fuel consuming areas, and (3) major agricultural and livestock areas. Frequency distributions of ionic composition, determined on 10 chemical constituents and on precipitation quantities for each site, showed wide variations in chemical concentrations and precipitation quantities from site to site. Of the 109 sites, 55 had data coverage for the year sufficient to characterize precipitation quality patterns on a nationwide basis. Except for ammonium and calcium, both of which showed largest concentrations in the agricultural midwest and plains states, the largest concentrations and loads generally were in areas that include the heavily industrialized population center of the eastern United States. Except for hydrogen, all chemical ions are inversely related to the quantity of precipitation depth. Precipitation quantities generally account for less than 30% of chemical variation in precipitation samples. However, precipitation quantities account for 30 to 65% of the variations of calcium concentrations in precipitation. In regions where precipitation has a large ionic proportion of hydrogen-ion equivalents, much of the hydrogen-ion concentration could be balanced by sulfate equivalents and partly balanced by nitrite-plus-nitrate equivalents. In the regions where hydrogen-ion equivalents in precipitation were smaller, ammonion-and calcium-ion equivalents were necessary, along with the hydrogen-ion equivalents, to balance the sulfate plus nitrite-plus-nitrate equivalent. (USGS)
W90-06239

2L. Estuaries

PARAMETER ESTIMATION IN STOCHASTIC MODELS FOR 2-D SHALLOW WATER FLOW.
Technische Univ. Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
P. G. J. ten Brummelhuis, and A. W. Heemink.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 248-257, 6 fig, 10 ref.

Descriptors: *Hydrologic models, *Model studies, *Estuaries, *Coastal waters, *Flow, *Shallow water, Model studies, WAQUA model, Mathematical studies, Stochastic process, Water currents.

A model for simulation of movement of shallow coastal waters was developed from the WAQUA program package. The two-dimensional equations, including some empirical laws with uncertain parameters, were used to describe the dynamics of the water movements. An algorithm was developed to estimate such parameters by minimizing a criterion determined by the difference between the output of the model and observations. Two cases were described. In one, the boundary conditions were exactly known, so the difference between the model and the data were only a result of the incorrect parameter values. The simulated data were treated as deterministic values, implying that no stochastic aspects were involved. In the second case, the boundary conditions were not known exactly and consisted of two parts: the input part which was known exactly and a random part where a system noise process was introduced. Here the uncertainty was limited to the open boundary condition. (See also W90-05621) (Cassar-PTT)
W90-05649

OPEN CHANNEL FLOW IDENTIFICATION. CASE STUDIES.
Rijkswaterstaat-Deltadienst, Rijswijk (Netherlands). Data Processing Div.
For primary bibliographic entry see Field 8B.
W90-05704

FLUVIAL HYDRODYNAMIC AND SEDIMENT TRANSPORT MODEL FOR THE CHESAPEAKE BAY WATERSHED.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
For primary bibliographic entry see Field 2J.
W90-05705

TOXIC ORGANIC COMPOUNDS IN SURFACE SEDIMENTS FROM THE ELIZABETH AND PATAPSCO RIVERS AND ESTUARIES: APPENDICES.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5B.
W90-05719

FISHERIES-OCEANOGRAPHY COORDINATED INVESTIGATIONS--FIELD OPERATIONS 1988.
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 8I.
W90-05737

TOXIC ORGANIC COMPOUNDS IN SURFACE SEDIMENTS FROM THE ELIZABETH AND PATAPSCO RIVERS AND ESTUARIES.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5A.
W90-05750

CHESAPEAKE BAY EARTH SCIENCE STUDY: INTERSTITIAL WATER CHEMISTRY--CHEMICAL ZONATION, TRIBUTARIES STUDY AND TRACE METALS.
Maryland Geological Survey, Baltimore.
J. M. Hill, P. J. Blakeslee, R. D. Conkwright, and J. McKeon.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-134399. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/053, November 1982. 68p, 11 fig, 2 tab, 24 ref, 5 append. EPA Grant R805693.

Descriptors: *Chemical interactions, *Chesapeake Bay, *Interstitial water, *Trace metals, *Water chemistry, Cadmium, Conductivity, Copper, Elizabeth River, Iron, James River, Lead, Nitrates, Oxidation-reduction potential, Patapsco River, Rhode River, Sediment chemistry, Sulfates, Sulfides, Ware River, Zinc.

The sediments of the Chesapeake Bay constitute a large reservoir of chemical species derived from natural and anthropogenic sources. The behavior of these materials in the estuary is determined by the physiochemical sedimentary environments in which they are found. Three major environments were identified, from the interstitial water chemistry as Northern Bay, Middle Bay, and Southern Bay. The Northern Bay is characterized by sulfide (pS) below detection limits, non-conservative behavior of the major ions, relatively positive redox potential (Eh) values, high carbon content of the sediment, complete SO4 (2-) reduction, and high dissolved Fe. The Middle Bay characteristics are: strongly negative Eh values (which are seasonally stable), high pS, intermediate carbon content, and variable degree of SO4(2-) reduction. The Southern Bay characteristics are: low carbon content, low degree of SO4(2-) reduction, NH4(+) below detection, and intermediate Eh values. The chemical sedimentary environments of five tributaries to the main Bay were sampled for interstitial water. A total of twenty-eight cores were taken from the

Patapsco, Rhode, Ware, Elizabeth and James Rivers. The interstitial water data for Eh, pH, pS, conductivity, Fe, and Mn are reported. The data from the Patapsco River indicates it is an extension of the Northern Bay environment, and the Elizabeth River is not directly comparable to the main Bay system. Cores were selected from the main Bay, and the Patapsco and Elizabeth Rivers for trace metal analyses of their interstitial waters. Pb, Cd, Cu, and Zn were analyzed for approximately 140 samples (14 cores). The data indicate that the concentration of the metals are greater than coastal seawater and river water, and comparable to concentrations found in municipal waste. (Author's abstract)
W90-05808

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM. STATISTICAL AND ANALYTICAL SUPPORT CONTRACT: FINAL REPORT. VOLUME II.
Martin Marietta Environmental Systems, Columbia, MD.
For primary bibliographic entry see Field 5A.
W90-05811

SPRAY DISPOSAL OF DREDGED MATERIAL IN LOUISIANA WETLANDS: HABITAT IMPACTS AND REGULATORY POLICY IMPLICATIONS.
Louisiana Sea Grant Coll. Program, Baton Rouge.
For primary bibliographic entry see Field 5E.
W90-05828

FIELD MEASUREMENTS OF DIRECTIONAL WAVE LOADS ON COASTAL STRUCTURES.
Rijkswaterstaat, Delft (Netherlands). Road and Hydraulic Engineering Div.
For primary bibliographic entry see Field 8B.
W90-05858

WAVE PENETRATION IN HARBOURS BY THE FINITE-ELEMENT SERIES-EXPANSION METHOD.
Bologna Univ. (Italy). Dipt. di Fisica.
For primary bibliographic entry see Field 8B.
W90-05859

HYDROLOGIC ANALYSIS FOR COASTAL WETLAND RESTORATION.
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 7A.
W90-05866

NORTH SEA BENTHOS: A REVIEW OF FIELD INVESTIGATIONS INTO THE BIOLOGICAL EFFECTS OF MAN'S ACTIVITIES.
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
For primary bibliographic entry see Field 4C.
W90-05874

HETEROTROPHIC NANNO- AND MICROPLANKTON IN COASTAL WATERS OF THE WESTERN INDIAN OCEAN.
Akademiya Nauk SSSR, Moscow. Inst. Okeanologii.
A. I. Kopylov.
Oceanology ONLGAE, Vol. 28, No. 4, p 508-512, Feb 1989. 1 fig, 3 tab, 7 ref.

Descriptors: *Coastal waters, *Indian Ocean, *Marine pollution, *Plankton, *Water pollution effects, Abundance, Bioindicators, Biomass, Coral islands, Heterotrophs.

The abundance and biomass of heterotrophic nannoplankton, infusoria and multicellular microzooplankton were determined in coastal waters of the western Indian Ocean in February-March 1984. The greatest abundances of these organisms were found in coastal ecosystems exposed to anthropogenic pollution. Considerable concentrations of heterotrophic nannoplankton and microplankton were found near coral islands outside the zone directly affected by the reef. These eukarotic microheterotrophs develop in considerable numbers and are actively involved in self-purification of marine coastal waters. Analysis of the data suggests that the abundance of heterotrophic organisms measuring 2-200 micron is an index of anthropogenic pollution of inshore marine ecosystems. (Author's abstract)
W90-05879

FORMATION OF POLAR SURFACE WATER, THE ICE EXPORT AND THE EXCHANGES THROUGH THE FRAM STRAIT.
Hamburg Univ. (Germany, F.R.). Inst. fuer Meereskunde.
B. Rudels.
Progress in Oceanography POCNA8, Vol. 22, No. 3, p 205-248, 1989. 17 fig, 5 tab, 31 ref, append.

Descriptors: *Ice-water interfaces, *Polar regions, *Saline-freshwater interfaces, *Water circulation, Density, Entrainment, Mixing, Runoff, Stratification.

Polar surface water is formed from two parent water masses: inflowing Atlantic water and fresh water from river run-off and net precipitation. Two possible modes for this formation are considered: (1) Entrainment, driven by mechanical stirring, takes place over the entire Polar Ocean and brings Atlantic Water into the surface layer; and (2) The interaction between the Atlantic Water and the fresh water supply occurs only on the shelves, while the mixing in the interior is inhibited by a thick advective layer of intermediate density formed on the shelves. The exchanges between the Polar Ocean and the North Atlantic and the resulting stratification are determined for the two cases. The derived transports are much smaller than those often encountered in the literature. Which mode dominates depends upon the fresh water discharge. From the analysis it is found that a larger fresh water contribution favors mixing on the shelves, while the entrainment in the interior becomes more important as the run-off diminishes. The present day situation is probably one where the shelf processes dominate. It is found that a complete removal of the river run-off may not affect the extent of the ice cover too seriously so that a comparatively high ice export can be maintained. This is because the higher salinity of the polar surface water gradually increases the fresh water buffer present in the Pacific inflow. (Author's abstract)
W90-05880

WATER QUALITY/WATER QUANTITY CONFLICTS IN CALIFORNIA.
McDonough, Holland and Allen, Sacramento, CA.
For primary bibliographic entry see Field 6E.
W90-05890

NATURAL SELECTION AND GENETIC ADAPTATION TO HYPERSALINITY IN JUNCUS ROEMERIANUS SCHELLE.
Gulf Coast Research Lab., Ocean Springs, MS. Botany Section.
L. N. Eleuterius.
Aquatic Botany AQBODS, Vol. 36, No. 1, p 45-53, December 1989. 2 tab, 19 ref. US Army Corps of Engineers Contract DACW01-72-C-0001 and National Park Service Contract CX500060993.

Descriptors: *Adaptation, *Genetics, *Hypersalinity, *Marsh plants, *Natural selection, *Plant morphology, *Rushes, *Salt tolerance, *Tidal marshes, Evolution, Growth, Leaves, Phylogeny, Saline soils, Salinity, Salt flats, Salt marshes, Soil water.

In Mississippi, the rush Juncus roemerianus Schelle dominates approximately 93% of the tidal marsh and grows over a wide range of intertidal marsh habitats. J. roemerianus was found to be composed of genetically distinct populations using reciprocal transplant studies and common environment experiments. The soil water salinity of tidal marshes is the selective force at work. Adaptation is through natural selection for high salinity tolerance. Morphological adaptation has resulted in dwarf plants, with very short mature leaves (average 66 cm), occurring on hypersaline salt flats (35 to 65 ppt seasalts). Under a less saline regime (15 to 45 ppt seasalts), mature plant leaves were moderate in length (average 122 cm) and plants growing under a very low salinity regime (3 to 10 ppt seasalts) had the longest leaves (average 215 cm) reported for the species. Three populations of J. roemerianus were used in this study. Reciprocal transplant studies showed that plants from habitats of higher salinity could be successfully transplanted into habitats of lower soil water salinity, but not form lower to higher salinity areas, indicating that salt tolerance and adaptation is important to survival. Plants from the three populations were grown in a common environment experiment for 3 years with relatively high applications of nitrogen, phosphorus and potassium fertilizer. Although the leaves of dwarf plants doubled in length during the second year of the experiment, they did not increase further during the third year. Leaf length was significantly different among the three populations. Soil water salinity is the selective force causing genetic differentiation in J. roemerianus. (Author's abstract)
W90-05896

EFFECT OF BOAT MOORINGS ON SEAGRASS BEDS NEAR PERTH, WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Centre for Water Research.
For primary bibliographic entry see Field 4C.
W90-05897

LITTER PRODUCTION IN A MANGROVE STAND OF THE SAUDI ARABIAN RED SEA COAST.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Faculty of Marine Science.
S. M. Saifullah, A. K. Khafaji, and A. S. Mandura.
Aquatic Botany AQBODS, Vol. 36, No. 1, p 79-86, December 1989. 2 fig, 2 tab, 26 ref.

Descriptors: *Coastal waters, *Litter, *Mangrove swamps, *Marine environment, *Red Sea, *Saudi Arabia, *Wetlands, Aquatic productivity, Decomposing organic matter, Environmental effects, Flowering, Leaves, Seasonal variation.

Mangrove litter is a source of energy to marine organisms existing in waters adjacent to mangrove habitats. Mangroves of the Red Sea are known to grow in one of the hottest and most saline areas on earth. The average daily production of litter in a mangrove stand located in the central part of the Saudi Arabian Red Sea coast (Ras Hatiba), was estimated to be 2.16 g dry weight/sq m/day during 1986 and was found to be comparable with other productive mangrove habitats of the world. Litter was collected monthly, and after drying was sorted out and weighed for different compartments or fractions of litter like leaves, floral parts and fruits. Maximum litter fall occurred during March and April and is correlated with decreasing air temperatures in the preceding months. Of all the litter compartments, leaves contributed overwhelmingly to total litter throughout the year except during March and April, when fruits superseded them at 66% of total litter fall. The similarity in litter production in mangroves on a unit area basis from areas of the world widely apart, including the present one with extreme climatic conditions, suggests that it is not a function of climate, latitude or productivity of the area. (VerNooy-PTT)
W90-05898

SPECIES COMPOSITION AND BIOMASSES OF FISHES IN DIFFERENT HABITATS FOR A TROPICAL NORTHERN AUSTRALIAN ESTUARY: THEIR OCCURRENCE IN THE ADJOINING SEA AND ESTUARINE DEPENDENCE.
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.
S. J. M. Blaber, D. T. Brewer, and J. P. Salini.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 6, p 509-531, December 1989. 3 fig, 10 tab, 65 ref. Australian Fishing Industry Research Trust Account Grant 1985/85.

Descriptors: *Aquatic habitats, *Australia, *Coastal waters, *Estuarine environment, *Fish populations, *Species composition, Biomass, Estuarine fisheries, Marine fisheries, Spatial distribution, Tropical regions.

The fish communities of the five habitats comprising the Embley estuary in tropical northeast Australia were studied for 2.5 years. Fish faunas of each habitat were significantly different in both biomass and species composition. Mean biomasses were estimated as 7.1 g/sq m to 16.1 g/sq m for open water channels, 5.0 g/sq m for sandy mud beaches, 0.5 to 1.8 g/sq m for seagrass areas, 8.2 g/sq m for small mangrove creeks and inlets, and 70.6 g/sq m for intertidal mudflats adjacent to mangroves. Species composition and biomass of the estuarine fish population were compared with those of offshore water in adjoining Albatross Bay. Of the 197 species recorded in the estuary, 91 were also recorded in the bay. They fell into 6 species categories, comprising juveniles and adults found only in the estuary, only offshore or both in the estuary and offshore. Of the 106 species caught only inside the estuary, 59 also occur in shallow marine areas, which could not be sampled by trawling. This estuarine/shallow marine component forms at least one-third of the biomass in all estuarine habitats. The juveniles of 17 species of this group were found only in the estuary. Thirty species from the Embley (17 of which were Gobiidae) were considered truly estuarine. The number of species recorded, biomasses in the various habitats and differences between the fish faunas of the habitats are compared with published data from other tropical estuaries. The relatively high number of species from the Embley and the variations in biomasses and communities emphasize the importance of adequate sampling of all estuarine habitats. The authors concluded that that at least one-third of the species from the Embley estuary are 'estuarine-dependent'; they make up at least half of the fish biomass in all estuarine habitats. (Author's abstract)
W90-05908

MODELLING TIDAL ENERGETICS OF THE COLUMBIA RIVER ESTUARY.

Washington Univ., Seattle. School of Oceanography.
B. S. Giese, and D. A. Jay.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 6, p 549-571, December 1989. 11 fig, 1 tab, 24 ref. NSF Grant OCE-8208856.

Descriptors: *Columbia River Estuary, *Estuaries, *Flow characteristics, *Mathematical models, *Tidal energy, *Tidal hydraulics, Energy transfer, River flow, Tidal flats, Tidal rivers, Tidewater, Topography.

The Columbia River Estuary is shallow and has a mixed diurnal and semidiurnal tide, strong riverflow, broad tidal flats and variable channel cross-section. It is weakly non-linear with respect to tidal forcing, as measured by a ratio to tidal amplitude to depth. These features, common to many shallow estuaries, were incorporated into a one-dimensional harmonic transport model. The harmonic method utilizes the fact that nearly all of the energy in the system is in a few fundamental tidal frequencies, the first overtides thereof and the mean flow. This allows the representation of the flow as a series of harmonic components whose spatial variability is determined by the model. The model provides a qualitative explanation for and accurate quantitative predictions of along-channel variations in tidal properties in terms of the momentum balance. Near the mouth of the estuary, the boundary shear stress, pressure gradient and acceleration terms are all important in the force balance, and the tide behaves like a damped oscillator. Far upriver the pressure gradient is primarily balanced by a friction at the bed, and tidal wave propagation can be described as a diffusion process. Changes in the channel width in mid-estuary cause partial reflection of the tidal wave and a maximum in tidal range. The distribution of the time averaged energy fluxes was also determined from the model. Analysis shows that there are two regions of high energy dissipation, near the mouth of estuary and far upriver. These two regions of high dissipation are separated by a region of low dissipation, the energy flux divergence minimum. This spatial division of the estuary is mirrored in the system biology and geology. It is likely that the energy flux divergence minimum is a common feature of shallow estuaries with strong riverflow. (Author's abstract)
W90-05909

COMPOSITION OF LIGNIN IN ESTUARINE SUSPENDED PARTICULATES AND THE DISTRIBUTION OF PARTICULATE LIGNIN IN ESTUARIES AS DETERMINED BY CAPILLARY GAS CHROMATOGRAPHY OF CUPRIC OXIDE OXIDATION PARTICLES.

Lancaster Univ. (England). Dept. of Environmental Sciences.
A. D. Reeves, and M. R. Preston.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 6, p 583-599, December 1989. 8 fig, 4 tab, 23 ref.

Descriptors: *Environmental tracers, *Estuaries, *Gas chromatography, *Lignin, *Particulate matter, *Sediments, *Suspended solids, *Vascular tissues, Copper compounds, Diagenesis, England, Neap tides, Path of pollutants, Plant tissues, Sample preparation, Spatial distribution, Spring tides, Tides, Tracers.

The use of organic markers in the differentiation of organic inputs to sediments has proved to be a valuable tool in the examination of a number of major problems facing the environmental chemist such as the reconstruction of the depositional and diagenetic histories of recent estuarine sediments and the determination of the contribution of pollutant inputs to the organic fraction of these sediments. The contribution of lignin to the estuarine suspended particulate fraction is described in terms of its distribution over a spring tide and a neap tide in the Tamar Estuary, Southwest England and the Mersey Estuary, Northwest England. Suspended particulate samples were treated with copper oxide/sodium hydroxide (CuO-NaOH) at 170 C to yield simple, lignin-derived phenolic compounds, which were separated, derived and quantified by capillary gas chromatography with flame ionization detection (GC-FID). Estuarine distributions of particulate lignin are described and the sources and compositional changes of the lignin identified. Comparison of the lignin concentrations in the suspended material with those in the underlying sediment reveals that lignin is preferentially enriched in the suspended material. In both estuaries the low levels of p-coumaric acid indicated that there is little degraded, non-woody tissue in the suspended material and/or that the inputs of gymnosperm or angiosperm woods that do not contain p-coumaric or ferulic acids are dominant. (VerNooy-PTT)
W90-05910

MINERALIZATION OF CHITIN IN THE SEDIMENTS OF THE YTHAN ESTUARY, ABERDEENSHIRE, SCOTLAND.

Aberdeen Univ. (Scotland). Dept. of Genetics and Microbiology.
K. Hillman, G. W. Gooday, and J. I. Prosser.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 6, p 601-612, December 1989. 5 fig, 3 tab, 13 ref. NERC Grant 82.9080.

Descriptors: *Biodegradation, *Chitin, *Decomposition, *Estuarine environment, *Mineralization, *Scotland, *Sediments, Animal tissues, Carbon cycle, Deposition, Nitrogen cycle, Polymers, Sediment-water interfaces.

Chitin is produced annually, on a worldwide scale, in quantities second only to those of cellulose; its mineralization is thus of great ecological significance as it enters into both carbon and nitrogen cycles. Reliable methods have been developed for the quantitative estimation of chitin, chitosan and chitin deacetylase in sediment samples, as well as two methods for the estimation of chitinase in these samples. The differing substrates used in the latter two methods have produced distinct 'depth profiles' for chitinase activity which suggest the presence of more than one chitinolytic system in the sediments of the Ythan estuary. Studies on the mineralization of chitin (squid pen) in these sediments have revealed a complex system with a number of unexpected features. The rate of chitin degradation was reduced in late summer, possibly due to the heavy seaweed growth which covers the mud flats at this time, although the potential degradative activities of the enzymes chitinase and chitin deacetylase were higher in summer than winter. The proportional rates of degradation of chitin, chitosan and cellulose were similar in both the absence and presence of seaweed overgrowth, although the apparent rates of degradation of these substrates were higher in the absence of seaweeds. Core samples have indicated that the major input of chitin to the sediment ecosystem occurs via deposition at the surface, while the input of chitosan (the deacetylated polymer) occurs via its production within the sediment, primarily within the upper 5 cm of sediment. The concentrations of both these polymers decreased sharply below an 'interface' between aerobic and anoxic sediments. (Author's abstract)
W90-05911

FILTRATION ACTIVITY OF A SERPULID POLYCHAETE POPULATION, FICOPOMATUS ENIGMATICUS (FAUVEL), AND ITS EFFECTS ON WATER QUALITY IN A COASTAL MARINA.

Cape Town Univ. (South Africa). Dept. of Zoology.
B. R. Davies, V. Stuart, and M. de Villiers.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 6, p 613-620, December 1989. 3 fig, 23 ref.

Descriptors: *Biofiltration, *Coastal waters, *Marinas, *Marine environment, *Polychaetes, *Water pollution treatment, *Water quality control, Animal populations, Aquatic weed control, Feeding rates, Particulate matter, Sago pondweed, South Africa.

Ficopomatus enigmaticus (Fauvel) is a cosmopolitan tube worm which occurs in warm temperate and tropical estuaries and in coastal lakes open to the sea. An estimate of the total standing stock of F. enigmaticus in the Marina da Gama, Zandvlei, near Cape Town was made, and some aspects of the animals' filter-feeding behavior investigated. Working on values of 5.23 g dry mass of worm (excluding tube)/sq m on the submerged aquatic plant Potamogeton pectinatus L., plus 84.9 g/sq m on the canal walls, the total standing stock of the serpulid was estimated at 0.64 to 5.12 tons (an average of 1.4 tons on Potamogeton, 1.48 tons on canal walls). At the average particle concentration of Marina water of 5.27 mg/L, the clearance rate of F. enigmaticus was 8.59 mg/mg worm/hr, resulting in an ingestion rate of 45.27 mg/mg worm/hr of particles in the size range 2 to 16 micrometers. Clearance and digestion rates both increased in direct proportion to feed concentration. Using estimates of total standing stocks within the Marina, the F. enigmaticus population clears 2.47 times 10 to the 7th power liters of water/hour and consumes 130 kg of particles in the 2 to 16 micrometer size range. Thus, the entire volume of the Marina will be filtered in 26.1 hours through the activities of this animal alone, illustrating its importance for the maintenance of water quality within this moderately polluted system. Although F. enigmaticus may be viewed as a nuisance by inhabitants and users of the Marina, eradication on the animal should not be an option in this system in view of its filtration role. Similarly, since P. pectinatus supports some 49% of the total dry mass on Ficopomatus within the Marina, mechanical harvesting strategies should ensure the maintenance of the plant and, hence of the attached worm within the system. (VerNooy-PTT)
W90-05912

SALINITY TOLERANCE OF CORBULA TRIGONA (BIVALVIA: CORBULIDAE) FROM A WEST-AFRICAN LAGOON AND ITS VARIATIONS.

Lyon-1 Univ., Villeurbanne (France). Dept. de Biologie Animale et Ecologie.

J. L. Maslin.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 2, p 205-223, December 1989. 6 fig, 4 tab, 54 ref.

Descriptors: *Bays, *Clams, *Lagoons, *Mollusks, *Saline lakes, *Salt tolerance, *West Africa, Benin, Corbula, Lethal limit, Saline water, Salinity.

Lake Aheme is one of the coastal lagoons of Benin (West Africa). It is subjected to large fluctuations in salinity on an annual cycle. Batches of Corbula trigona, the most abundant bivalve species in this brackish-water lagoon, were tested to assess their salinity tolerance. The responses of individuals from two natural populations living in very different salinities (overall lower salinity in the north, and higher salinity in the south) were compared. From both acute and gradual (involving acclimation) tests, a lower and an upper lethal concentration were determined. These concentrations were 0.6-25.0 parts per thousand for the northern population and 2.9-32.0 parts per thousand for the southern population in acute tests. They were 0.2-20.5 parts per thousand and 0.8-28.0 parts per thousand in gradual tests. Corbula appears to be a eury-mixohaline organism, with salinity tolerances that vary according to the geographical origin of the population, but not according to individual size. These results are considered in the context of the variations encountered by the species in the Lake Aheme system. (Author's abstract)
W90-05923

EFFECTS OF ICE-BREAK ON THE STRUCTURE AND DYNAMICS OF A BENTHIC DIATOM COMMUNITY IN THE NORTHERN BALTIC SEA.
Uppsala Univ. (Sweden). Inst. of Ecological Botany.
P. J. M. Snoeijs, and U. Kautsky.
Botanica Marina BOTNA7, Vol. 32, No. 6, p 547-562, November 1989. 10 fig, 2 tab, 50 ref, 2 append.

Descriptors: *Baltic Sea, *Benthic flora, *Diatoms, *Estuaries, *Ice breakup, *Population dynamics, *Species composition, Artificial substrates, Colonization, Comparison studies, Ice cover, Phytoplankton, Seasonal variation.

The structure and dynamics of a vernal benthic diatom community were studied in a shallow brackish-water coastal ecosystem. Two kinds of substrata, granite panels and polycarbonate strips, were submerged for colonization so that the effects of substratum-type could also be studied. Two periods of constancy in species composition (March and the second half of April) were separated by a period of rapid change during ice-break. In March, under the ice cover, the tube-dwelling diatom Navicula ramosissima was dominant in low-diversity communities on both substrata. By the end of April, after ice-break, another tube-dwelling species (Amphipleura rutilans) dominated on the granite panels, but some species that had been abundant in the vernal phytoplankton bloom in the first half of April (especially Chaetoceros spp.) dominated on the polycarbonate strips. More taxa occurred on the polycarbonate strips than on the granite panels, but Shannon-Weaver diversity was generally higher on the granite panels. The length of incubation of the polycarbonate strips (minimum 12 days) influenced total cell numbers and relative abundances of some species, but had only minor effects on overall community composition and diversity. The abundance of individual species was influences by the interval between submergence and sampling; among strips sampled on the same date, those submerged more recently had higher abundances of species characteristic of a later stage in succession. The general pattern of succession may reflect differences in species' responses to light availability. The differences between the communities on polycarbonate strips and granite panels may reflect difficulties in attachment to the less porous artificial substratum. (Author's abstract)
W90-05925

PHYTOPLANKTON BLOOMS IN THE OLIGOTROPHIC OPEN SOUTH ADRIATIC WATERS.
Biological Inst., Dubrovnik (Yugoslavia).
D. Vilicic, Z. Vucak, A. Skrivanic, and Z. Grzetic.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 89-107, December 1989. 10 fig, 2 tab, 37 ref.

Descriptors: *Adriatic Sea, *Advection, *Mediterranean Sea, *Oceanography, *Oligotrophy, *Phytoplankton, Eutrophication, Hydrologic data collections, Meteorological data collection, Primary productivity.

The phytoplankton bloom recorded in April 1987 in the offshore south Adriatic waters was compared with a less extensive bloom in April 1986. Differences between 1986 and 1987 hydrographic data occurred because of different hydrometeorological conditions. April 1987 was a period of a pronounced advection of eastern Mediterranean water (salinity > 38.65 ppt, temperature > 14 C) into the Adriatic, and the extensive phytoplankton bloom was probably induced by earlier upwelling. The difference between the situations in 1986 and in 1987 can be attributed to the measurements being made at two different stages of the phytoplankton blooms. In 1986, the measurements were made during the first phase, whereas in April 1987 they were made during the late phase of the bloom. The complex dynamics of the south Adriatic waters probably involve upwelling/downwelling and advection. (Author's abstract)
W90-05966

MERCURY DISTRIBUTION IN THE KRKA RIVER ESTUARY (EASTERN ADRIATIC COAST).
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
For primary bibliographic entry see Field 5B.
W90-05967

STUDIES ON THE TRANSFER OF HEAVY METALS BETWEEN SEDIMENTARY PHASES WITH A MULTI-CHAMBER DEVICE: COMBINED EFFECTS OF SALINITY AND REDOX VARIATION.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W90-05968

CONSERVATIVE MIXING IN ESTUARIES AS AFFECTED BY SORPTION, COMPLEXING AND TURBIDITY MAXIMUM: A SIMPLE MODEL EXAMPLE.
Nederlands Inst. voor Onderzoek der Zee, Texel.
E. K. Buursma, and P. Rauardij.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 251-258, December 1989. 4 fig, 1 tab, 6 ref.

Descriptors: *Estuaries, *Metals, *Mixing, *Path of pollutants, *Sorption, *Turbidity, Advection, Model studies, Organic matter, Salinity, Sedimentation, Simulation analysis, Suspended solids.

A simulation model calculation was made for the correlation of concentrations of metal species with salinity for a steady-state estuary containing a turbidity maximum, but having no residual sedimentation. The simulation model is based on a one-dimensional mixing and flushing model. The model estuary is divided into 15 compartments of equal length and 2 ppt salinity interval each, through which transport of metal, organic matter and particulate matter occurs. Four different cases have been calculated with various values of the organic complexed metal stability constant and the distribution coefficient. The results of the concentrations of dissolved ionic metal, organic complexed metal and particulate metal were plotted against salinity. As dissolved organic matter is high in freshwater and zero in seawater, there is an apparent proportionality of organic complexed metal with salinity, whereas dissolved ionic metal and particulate metal can either decrease or increase with salinity, as they have non-linear correlations. The amount of metal in particulate matter has a clear maximum at the turbidity maximum. The distribution of total metal depends on the factors K organic complexed metal stability constant st and K distribution. Apparent linear mixing plots of concentrations of metal species with salinity do not mean that the metal species will necessarily behave conservatively, but that exchange processes of complexing and sorption should be taken into account. (Geiger-PTT)
W90-05971

EFFECT OF TEMPERATURE AND FOOD ON HEXAVALENT CHROMIUM TOXICITY TO THE MARINE NEMATODE MONHYSTERA DISJUNCTA.
Ghent Rijksuniversiteit (Belgium). Zoology Inst.
For primary bibliographic entry see Field 5C.
W90-06019

HARMONIC ANALYSIS OF TIDAL MODEL TIME SERIES,
Institute of Ocean Sciences, Sidney (British Columbia).
M. G. G. Stone, and R. F. Harvey.
Advances in Water Resources AWREDI, Vol. 12, No. 3, p 109-120, September 1989. 5 fig, 5 tab, 22 ref.

Descriptors: *Tides, *Tidal waves, *Mathematical models, *Time series analysis, Computer programs, Harmonic analysis, Numerical analysis, Statistical methods.

The development of harmonic analysis of tides is reviewed with particular attention to the analysis technique introduced by Godin and circulated by Foreman. A harmonic analysis requires calculating the amplitudes and phases for a finite number of sinusoidal functions with known frequencies. Related issues include consistuent selection, time series length, confidence regions and inference. It is shown that since numerical model time series have a much lower non-tidal content than observational time series, constituents can be separated with shorter record lengths. Experience has pointed out a number of guidelines which can be recommended for the analysis of tidal-model time series. For example, it is important to maintain consistency between model forcing and harmonic analysis. A second important point is that the constituents to be included in the harmonic analysis should be chosen by the user and not by the analysis program. Constituents chosen by the Rayleigh selection criterion in the analysis program may not necessarily include all of the constitutents in the model time series. If a model can be run sufficiently long that all transients have decayed below machine precision at the beginning of the analysis period, and the analysis period itself is long enough to resolve the constituents, then including all constituents in the analysis is the best strategy. However, it may be either difficult to determine the time required for this decay, or it may not be economically feasible to run a model this long. In such cases, inference may be required to resolve closely-separated constituents. (Chonka-PTT)
W90-06023

HARMONIC STRUCTURE OF ENGLISH CHANNEL/SOUTHERN BIGHT TIDES FROM A WAVE EQUATION SIMULATION.
Skidaway Inst. of Oceanography, Savannah, GA.
F. E. Werner, and D. R. Lynch.
Advances in Water Resources AWREDI, Vol. 12, No. 3, p 121-142, September 1989. 43 fig, 1 tab, 21 ref. NSF grant CEE-8352226.

Descriptors: *Mathematical models, *Simulation analysis, *Tidal waves, *Tides, English Channel, Harmonic analysis, Least squares method, Time series analysis.

The harmonic structure of a long-term time-stepping simulation is obtained by least-squares decomposition. The structure of 11 major constituents used to force the model is displayed, reproducing the major tidal features of the system. The problem of incomplete field data is analyzed in terms of these and 40 additional constituents which were generated internally. At least two semi-diurnal constituents which had been previously neglected are shown to be contributors to apparent errors in time-domain comparisons with field data. By ex-

cluding these and all other unforced constituents, improved root-mean-square error estimates are obtained in the time domain. (Author's abstract)
W90-06024

FINITE ELEMENT STUDY OF TIDAL FLOW DATA FOR THE NORTH SEA AND ENGLISH CHANNEL.
Notre Dame Univ., IN. Dept. of Civil Engineering.
W. G. Gray.
Advances in Water Resources AWREDI, Vol. 12, No. 3, p 143-154, September 1989. 31 fig, 10 ref.

Descriptors: *English Channel, *Finite element method, *Model studies, *North Sea, *Tidal currents, *Tides, Flow measurement, Flow models, Model testing, Principal component analysis.

An implicit wave equation model has been applied to a database for two dimensional tidal flow in the North Sea and English Channel. The simulation was carried out for 190 days to allow for a direct comparison with field measurements over a one-day period and for decomposition of the tide into its fifty-one principal components. No attempt was made to tune the model to the data. The purpose of the study is to facilitate a comparison of numerical models of the data set as well as to demonstrate the ability of the current model to capture the flow physics. (Author's abstract)
W90-06025

FINITE DIFFERENCE SIMULATION MODEL OF TIDAL FLOW IN THE ENGLISH CHANNEL AND THE SOUTHERN NORTH SEA.
Rijkswaterstaat, The Hague (Netherlands). Div. of Tidal Waters.
N. Praagman, J. Dijkzeul, R. van Dijk, and R. Plieger.
Advances in Water Resources AWREDI, Vol. 12, No. 3, p 155-164, September 1989. 6 fig, 9 ref.

Descriptors: *English Channel, *Finite difference methods, *Flow models, *Model studies, *North Sea, *Simulation analysis, *Tidal currents, *Tides, Calibrations, Data collections, Hydraulic geometry, WAQUA model.

Two simulations for tidal flow are carried out with a finite difference model known as the WAQUA package. The models were set up with the geometry data from the dataset provided by the Tidal Forum held at the Computational Methods in Water Resources Conference held in Lisbon in 1986. After calibration, results obtained using the model agree well with observations. The region under consideration, the southern part of the North Sea and the English Channel, is probably not the best test case to compare the numerical models since there are not enough discriminating factors in this water system. (Chonka-PTT)
W90-06026

OCCURRENCE AND SEASONAL VARIATION OF HEAVY METALS IN THE OYSTER SACCROSTREA IRIDESCENS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
For primary bibliographic entry see Field 5B.
W90-06039

HEAVY METALS IN THE EASTERN OYSTER, CRASSOTREA VIRGINICA, OF THE MISSISSIPPI SOUND.
Gulf Coast Research Lab., Ocean Springs, MS. Analytical Chemistry Section.
For primary bibliographic entry see Field 5B.
W90-06041

INTERSTITIAL WATER CHEMISTRY OF PU239,240 AND AM241 IN THE SEDIMENTS OF THE NORTH-EAST IRISH SEA.
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Directorate of Fisheries Research.
For primary bibliographic entry see Field 5B.
W90-06056

SEASONAL PATTERNS OF PHYTOPLANKTON BIOMASS AND PRODUCTIVITY IN A TROPICAL ESTUARINE COMPLEX (WEST COAST OF INDIA).
National Inst. of Oceanography, Panaji (India).
V. P. Devassy, and J. I. Goes.
Proceedings of the Indian Academy of Sciences (Plant Sciences) PIPLDS, Vol. 99, No. 5, p 485-501, October 1989. 13 fig, 3 tab, 21 ref.

Descriptors: *Aquatic productivity, *Estuarine environment, *India, *Phytoplankton, Chlorophyll a, Monsoons, Seasonal variation, Tropical regions.

Phytoplankton cell numbers and chlorophyll a determinations were made during the premonsoon, monsoon and postmonsoon periods in the Mandovi-Zuari estuarine complex (west coast of India). Primary productivity estimates agreed well with chlorophyll a and phytoplankton cell numbers. The consequent decline in salinity with the onset of monsoon was found to be an important factor controlling the distribution, abundance and productivity of phytoplankton. As compared to the Zuari estuary, the Mandovi retained typical estuarine conditions and a greater phytoplankton biomass. Based on primary productivity estimations, the potential fishery resource of this estuarine complex has been computed as 18.6 metric tons/sq km/yr or 1714 metric tons/yr for the entire estuarine complex. (Author's abstract)
W90-06159

NATIONAL BENTHIC SURVEILLANCE PROJECT: PACIFIC COAST. PART I: SUMMARY AND OVERVIEW OF THE RESULTS FOR CYCLES I TO III (1984-86).
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 5B.
W90-06197

NATIONAL BENTHIC SURVEILLANCE PROJECT: PACIFIC COAST. PART II: TECHNICAL PRESENTATION OF THE RESULTS FOR CYCLES I TO III (1984-86).
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
For primary bibliographic entry see Field 5B.
W90-06198

ENVIRONMENTAL ASSESSMENT OF OVERFLOW DREDGING IN MOBILE BAY, ALABAMA.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 6G.
W90-06204

SALINITY AND FLOW RELATIONS AND EFFECTS OF REDUCED FLOW IN THE CHASSAHOWITZKA RIVER AND HOMOSASSA RIVER ESTUARIES, SOUTHWEST FLORIDA.
Geological Survey, Tampa, FL. Water Resources Div.
D. K. Yobbi, and L. A. Knochenmus.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4044, 1989. 48p, 23 fig, 5 tab, 14 ref.

Descriptors: *Chassahowitzka River, *Estuaries, *Florida, *Homosassa River, *Saline water intrusion, *Surface-groundwater relations, Regression analysis, Saline-freshwater interfaces.

The Chassahowitzka and Homosassa Rivers Florida, are spring-fed streams flowing into the Gulf of Mexico that may be affected by future development of groundwaters. Reduction of streamflow may cause an upstream movement of saltwater in the rivers. Data on flow, tide, and salinity define the physical characteristics of both estuaries. Vertical and longitudinal salinity profiles indicate that the estuaries are reasonably well mixed for the streamflow and high-tide conditions observed during the study. Estimates of the daily maximum upstream locations of the vertically averaged 3-ppt and 5-ppt salinities in the Chassahowitzka River and the vertically averaged 2-ppt and 5-ppt salinities in the Homosassa River are described by multiple linear regression analysis using daily mean streamflow of each river and high-tide stage of the gulf. For the vertically averaged 3-ppt and 2-ppt salinities, the square of the correlation coefficient for the predictive equations ranged from 0.77 to 0.85. For the vertically averaged 5-ppt salinities, the square of the correlation coefficient for the predictive equations ranged from 0.73 to 0.88. Upstream movement of salt-water due to pumping 40 million gal/day from a well field near the headwater springs of the Chassahowitzka and Homosassa Rivers was determined. Pumping at this rate from the Chassahowitzka River would cause a 15% reduction of average spring flow, resulting in an upstream movement of both the vertically averaged 3-ppt and 5-ppt of about 0.3 mile. In the Homosassa River, pumping would cause a 13% reduction of average spring flow, resulting in an upstream movement of both the vertically averaged 2-ppt and 5-ppt salinities of about 0.1 mile. (USGS)
W90-06249

PHYSICAL AND CHEMICAL PROPERTIES OF SAN FRANCISCO BAY, CALIFORNIA, 1980.
Geological Survey, Menlo Park, CA. Water Resources Div.
A. Y. Ota, L. E. Schemel, and S. W. Hager.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-421, 1989. 251p, 4 fig, 6 tab, 26 ref.

Descriptors: *Hydrologic data, *Sampling, *San Francisco Bay, *Water quality, Chemical properties, Continuous sampling, Discrete sampling, Nutrients, Physical properties.

The U.S. Geological Survey conducted hydrologic investigations in both the deep water channels and the shallow-water regions of the San Francisco Bay estuarine system during 1980. Cruises were conducted regularly, usually at two-week intervals. Physical and chemical properties presented in this report include temperature, salinity, suspended particulate matter, turbidity, extinction coefficient, partial pressure of CO_2, partial pressure of oxygen, dissolved organic carbon, particulate organic carbon, discrete chlorophyll a, fluorescence of photosynthetic pigments, dissolved silica, dissolved phosphate, nitrate plus nitrite, nitrite, ammonium, dissolved inorganic nitrogen, dissolved nitrogen, dissolved phosphorus, total nitrogen, and total phosphorus. Analytical methods are described. The body of data contained in this report characterizes hydrologic conditions in San Francisco Bay during a year with an average rate of freshwater inflow to the estuary. Concentrations of dissolved silica (discrete-sample) ranged from 3.8 to 310 micro-M in the northern reach of the bay, whereas the range in the southern reach was limited to 63 to 150 micro-M. Concentrations of phosphate (discrete-sample) ranged from 1.3 to 4.4 micro-M in the northern reach, which was narrow in comparison with that of 2.2 to 19.0 micro-M in the southern reach. Concentrations of nitrate plus nitrite (discrete-sample) ranged from near zero to 53 micro-M in the northern reach, and from 2.3 to 64 micro-M in the southern reach. Concentrations of nitrite (discrete-sample) were low in both reaches, exhibiting a range from nearly zero to approximately 2.3 micro-M. Concentrations of ammonium (discrete-sample) ranged from near zero to 14.2 micro-M in the northern reach, and from near zero to 8.3 micro-M in the southern reach. (USGS)
W90-06255

HYDRAULIC AND SALINITY CHARACTERISTICS OF THE TIDAL REACH OF THE PEACE RIVER, SOUTHWESTERN FLORIDA.
Geological Survey, Tampa, FL.
Y. E. Stoker, S. E. Henderson, and B. F. McPherson.
Available from Books and Open-File Report Sec-

tion, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4162, 1989. 46p, 26 fig, 4 tab, 6 ref. Project FL-377.

Descriptors: *Charlotte Harbor, *Florida, *Peace River, *Salinity, *Tidal rivers, Estuarine environment, Flow duration, Flow velocity, Freshwater inflow, Freshwater replacement time, Hydraulics, Low flow, Salinity stratification, Stages, Tidal currents, Tidal discharge, Tidewater.

The tidal reach of the Peace River in southwestern Florida extends about 26 miles upstream from Charlotte Harbor and is characterized by flow-direction reversals, low velocities, and salinity gradients that vary with freshwater inflow, tides, and wind. Flow reversals generally occur on each tide throughout most of the tidal reach, their upstream limit determined primarily by freshwater inflow and tide. Flow reversals occur at river mile 18.9 whenever freshwater inflows are less than about 1,000 cu ft/sec. Velocities were less than 0.3 ft/sec more than half the time at river mile 18.9. The volume of the flood and ebb tidal flows in the midreach of the tidal river (mile 11.5) on July 12-13, 1984, was about five times the volume of flood and ebb tidal flow near the upstream end of the tidal reach July 10-11, 1984 (mile 18.9). Salinity varied along the 26-mile river reach, across channel and with depth, depending upon complex patterns of flow, freshwater runoff, wind, tide, and salinity in Charlotte Harbor. Daily variations in salinity increased downstream and variations were larger near the surface than near the bottom. Regression analysis indicated that the location of the 0.5 ppt salinity will move upstream more than 2 river miles if low flows are reduced by 50%. Freshwater flushing of the lower 20-mile tidal reach, approximated from freshwater replacement time, varied from about 2 days during heavy freshwater runoff to 40 days during extreme low flows. (USGS)
W90-06258

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3B. Water Yield Improvement

JUNIATA SUBBASIN: LOW FLOW MANAGEMENT FRAMEWORK PLAN.
Susquehanna River Basin Commission, Harrisburg, PA.
D. W. Heicher, and G. H. Hirschel.
Susquehanna River Basin Commission, Harrisburg, Pennsylvania. Publication No. 126, January 1990. 138p, 15 fig, 46 tab, 28 ref, 3 append.

Descriptors: *Juniata River, *Low-flow augmentation, *Pennsylvania, *Susquehanna River Basin, *Water use, Consumptive use, Drought, Water deficit, Water storage, Water supply.

The 7-day 10-year low flow (Q7-10) value was used as an indicator to identify historical low flow periods, and to determine potential water deficits within watersheds of the Juniata Subbasin in south central Pennsylvania during a repeat of the most severe historical low flow period. In general, upstream consumptive use ranges from about 4% to 6% of the Q7-10 value at the outlets of major stream sections in the subbasin. At the outlets of Sections 2, 3 and 4, total upstream consumptive uses are expected to be less in 1990, 2000, and 2010 than they were in the base year. Total consumptive use in the subbasin under baseline low flow conditions is estimated to be 13.87 million gallons per day (mgd). Consumptive use during potential low flow conditions in the year 2010 is projected to be reduced to about 13.66 mgd. More than half of the subbasin's total consumptive use occurs in Section 2. It is estimated that if meteorological conditions producing the 1966 drought were repeated under baseline conditions, about 6,769 acre-ft of water would be required to maintain Q7-10 flows at the mouth of the Juniata River. An estimated 6,745 acre-ft of water would be required if the 1966 drought were repeated in the year 2010. The amount of water storage needed to maintain flows at the Q7-10 value at the outlet of each stream section is also provided. (Lantz-PTT)
W90-06216

3C. Use Of Water Of Impaired Quality

WATER USE BY AND SALINITY EFFECTS UPON TRICKLE IRRIGATED GRAPE PRODUCTION IN THE SOUTHERN BASIN AND RANGE PROVINCE OF NEW MEXICO.
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
R. S. Van Pelt, and P. J. Wierenga.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-145202/AS. Price codes: A05 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report No. 244, August 1989. 76p, 8 tab, 31 fig, 51 ref. USGS State Project no. 1345627.

Descriptors: *Consumptive use, *Crop production, *Salinity, *Trickle irrigation, *Vine crops, Field studies, Fruit quality, Groundwater quality, Irrigation water, New Mexico, Saline soils, Soil treatment, Water requirements, Water use efficiency.

Irrigated agriculture in the Southwest depends upon the continued availability of good quality water. Recent increases in the cost of pumping have prompted many growers to consider planting high value crops such as wine grapes. Recent advances in irrigation technology, particularly trickle irrigation, may make production of quality fruit possible with groundwater reserves of limited availability or poor quality. No regional guidelines exist to assist the potential grower in locating and establishing vineyards based on the water resources present. Field trials were conducted to provide information necessary for the formulation of such guidelines. Cabernet Sauvignon grapes in a trickle irrigated commercial vineyard in southern New Mexico were irrigated with water of three salinities (350, 1000, and 1500 mg/L TDS). Grapes receiving the 350 mg/L water were irrigated with water volumes representing 60, 80, 100, and 120% of predicting evapotranspiration. Consumptive use of water by the vines was estimated from lysimeter water balance data. The results indicate grapes may be produced with no more than 500 mm of water/year of which nearly half may be expected in the form of precipitation. Soil solution salinity levels in vine root zones were not found to be significantly greater than that of the applied irrigation water. Fruit production of acceptable quality was obtained from vines irrigated with water of all salinity levels tested. (USGS)
W90-06251

3E. Conservation In Industry

WATER USE AND COAL DEVELOPMENT IN EASTERN MONTANA: WATER AVAILABILITY AND DEMANDS. APPENDIX A: COMPUTER PROGRAM DOCUMENTATION FOR PART VII, SECTION A: DEMANDS FOR WATER IN COOLING.
Montana State Univ., Bozeman. Dept. of Agricultural Economics and Economics.
For primary bibliographic entry see Field 6D.
W90-06177

3F. Conservation In Agriculture

AERATION CHANGES AFTER IRRIGATION IN A CLAY SOIL.
Sveriges Lantbruksuniversitet, Uppsala. Div. of Agricultural Hydrotechnics.
M. McAfee, J. Lindstrom, and W. Johansson.
Journal of Soil Science JSSCAH, Vol. 40, No. 4, p 719-729, December 1989. 6 fig, 5 tab, 19 ref.

Descriptors: *Clays, *Crop yield, *Irrigation effects, *Soil aeration, *Soil-water-plant relationships, Aeration, Field tests, Irrigation efficiency, Root zone, Soil absorption capacity, Soil physical properties, Soil saturation, Sweden, Wetting.

The effects on soil aeration of varying both the intensity and quantity of water applied per irrigation were investigated in Sweden in a field experiment on clay soil. Soil physical and soil aeration parameters were measured before, and for up to 7 days after irrigation. Irrigation increased the volumetric water content of the surface layer by approximately 8% v/v. However, periods of waterlogging were short on this soil. Significant decreases in soil oxygen content in the days after irrigation were caused by increased soil and root respiration. In terms of subsequent crop growth, the practice of applying 30 mm irrigation water at an intensity of 5 mm/hour was shown to be superior to irrigations providing half this quantity (15 mm) or double this intensity (10 mm/hour). The lower intensity irrigations decreased soil permeability by homogeneous wetting and swelling, and thus more of the water applied was recovered in the soil. Approximately one third of the water applied at the higher intensity was lost through cracks, and wetting of the soil was less uniform. (Author's abstract)
W90-05915

WATER USE BY AND SALINITY EFFECTS UPON TRICKLE IRRIGATED GRAPE PRODUCTION IN THE SOUTHERN BASIN AND RANGE PROVINCE OF NEW MEXICO.
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
For primary bibliographic entry see Field 3C.
W90-06251

HEAT SHOCK PROTEIN EXPRESSION IN THERMOTOLERANT AND THERMOSENSITIVE LINES OF COTTON.
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
M. A. O'Connell.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-145210/AS. Price codes: A03 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report No. 246, November 1989. 30p, 6 fig, 44 ref. State project 1345680.

Descriptors: *Biotechnology, *Cotton, *Proteins, *Water stress, *Water use efficiency, Electrophoretic analysis, Heritable thermotolerance, Plant heat sensitivity, Plant heat tolerance.

A large proportion of the water absorbed by a plant is used to cool its leaves as the air temperature becomes too hot. If the molecular basis of heritable thermotolerance were understood, then improvements in water use by crop plants might be possible. The role of heat shock proteins (HSPs) in the expression of heritable thermotolerance in cotton was investigated. Comparisons were made between the expression of HSPs in genetically characterized heat-tolerant and heat-sensitive lines of cotton. These comparisons were based on electrophoretic analysis of in vivo labelled proteins. No differences were observed between the two lines with regard to: (1) the temperature at which HSP synthesis was introduced (37 C), or the temperature at which HSP synthesis was maximal (45 C); (2) the rates of recovery for HSP synthesis or in the duration of HSP synthesis; and (3) the major size classes of HSPs expressed in these two lines. Several unique HSPs were identified on two-dimensional gels: a 26 kDa HSP which was expressed in the tolerant cotton line and a 24 kDa and an a 18 kDa HSP which were expressed in the sensitive cotton line. However, the HSP pattern displayed in a heat-tolerant BC3 individual was that of the heat-sensitive parent. No alternation in HSP expression could be found which correlated with the heritable thermotolerance. (USGS)
W90-06253

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

CHANNEL RESISTANCE AT THE SIDE-WEIR LOCATION IN OPEN CHANNEL FLOW.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05663

BACKWATER COMPUTATION OF NATURAL RIVERS WITH EXTREME BANK OR FLOOD-PLAIN ROUGHNESS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2E.
W90-05673

RIFFLE-POOL FORMATIONS IN NORTHERN IRELAND RIVERS.
Department of Agriculture for Northern Ireland, Belfast.
For primary bibliographic entry see Field 8B.
W90-05690

RE-OPERATION OF OLD WATER SYSTEM IN NORTHERN IRAQ.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.
For primary bibliographic entry see Field 8B.
W90-05710

DESIGN OF ROADSIDE CHANNELS WITH FLEXIBLE LININGS.
Simons, Li and Associates, Inc., Fort Collins, CO.
Y. H. Chen, and G. K. Cotton.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A205-702. Price codes: A06 in paper copy, A01 in microfiche. Report No. FHWA-IP-87-7, April 1988. 112p, 32 fig, 6 tab, 25 charts, 23 ref, 4 append. Department of Transportation Contract DTFH61-84-C 00055.

Descriptors: *Channels, *Design criteria, *Liners, *Shoulder ditches, Erosion control, Fiberglass roving, Gravel, Jute, Riprap, Vegetation.

Flexible linings provide a means of stabilizing roadside channels. Flexible linings are able to conform to changes in channel shape while maintaining the overall lining integrity. Permanent flexible lining such as riprap, gravel, or vegetation reinforced with synthetic mat are suitable for hydraulic conditions similar to those requiring rigid linings. Vegetation or temporary linings are suited to hydraulic conditions where uniform flow exists and shear stresses are moderate. Design procedures are given for rock riprap, wire-enclosed riprap, gravel riprap, woven paper net, jute net, fiberglass roving, curled wood mat, synthetic mat, and straw with net. Special design procedures are presented for composite channels and channels with steep gradients. The design procedures are based on the concept of maximum permissible tractive force. Methods for determination of hydraulic resistance and permissible shear stress for individual linings are presented. Nomographs are provided for solution of uniform flow conditions in trapezoidal channels. Nomographs are also provided for determination of resistance characteristics for vegetation and permissible shear stress for soils. (Author's abstract)
W90-06184

ROANOKE RIVER WATER FLOW COMMITTEE REPORT. A RECOMMENDED WATER FLOW REGIME FOR THE ROANOKE RIVER, NORTH CAROLINA, TO BENEFIT ANADROMOUS STRIPED BASS AND OTHER BELOW-DAM RESOURCES AND USERS.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-173132. Price codes: A10 in paper copy, A01 in microfiche. Report No. NOAA-TM-NMFS-SEFC-216, February 1989. 221p, 46 fig, 25 tab, 82 ref, 3 append. Edited by Charles S. Manooch and Roger A. Rulifson.

Descriptors: *Bass, *Dam effects, *Flow discharge, *Reservoir releases, *Roanoke River, Dams, Ecosystems, Fish, Flow profiles, Flow velocity, North Carolina, Species diversity, Wetlands.

A Committee of 20 representatives of State and Federal agencies and university scientists was formed in 1988 to gather information on all resources of the lower Roanoke River watershed in North Carolina, and recommend a flow regime that will be mutually beneficial to these resources and their downstream users. The Roanoke River, in northeastern North Carolina, flows through an extensive floodplain of national significance. The wetland area is considered to be the largest intact, and least disturbed, bottomland forest ecosystem remaining in the Mid-Atlantic region. The diverse habitats of the system support a rich array of wildlife and fish species. The construction of six upstream dams in the 1950s and 1960s and the resulting water flow regulation has had an impact on downstream resources and those that use them, particularly during the spring. The striped bass-water flow issue is the most sensitive of those mentioned because of the national importance of the species. The flows in the post-impoundment years of relatively high Juvenile Abundance Index (JAI) are more similar to pre-impoundment flows than those of low JAI. This population of striped bass evolved under unregulated flows. Since the fishery was successful prior to flow regulation by the reservoirs, making the flows consistent with pre-impoundment flows is likely to improve the production of striped bass. The following flows are recommended: minimum allowable flow--4,000 cu ft/sec (cfs) (June 1-15) to 6,600 cfs (April 1-15); maximum allowable flow--9,500 cfs (June 1-15) to 13,700 cfs (April 1-15). The importance of moderate, sustained flow during the spawning period is emphasized. (Lantz-PTT)
W90-06185

JUNIATA SUBBASIN: LOW FLOW MANAGEMENT FRAMEWORK PLAN.
Susquehanna River Basin Commission, Harrisburg, PA.
For primary bibliographic entry see Field 3B.
W90-06216

WATER RESOURCES DATA COLLECTED DURING WATER YEAR 1988 AT SELECTED JAMES RIVER BASIN SITES IN NORTH DAKOTA AND SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06256

TREND ANALYSIS OF LAKE PARKER STAGE AND RELATION TO VARIOUS HYDROLOGIC FACTORS, 1950-86, LAKELAND, FLORIDA.
Geological Survey, Tampa, FL.
For primary bibliographic entry see Field 2H.
W90-06259

4B. Groundwater Management

MAPPING OUT A PLAN TO PROTECT ARIZONA'S GROUNDWATER.
Arizona Dept. of Environmental Quality, Phoenix. Office of Water Quality.
For primary bibliographic entry see Field 5G.
W90-06030

HYDROGEOLOGY OF WOOD COUNTY, WISCONSIN.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06225

HYDROGRAPHS FROM SELECTED OBSERVATION WELLS AND ANNUAL PUMPAGE FROM MUNICIPAL SUPPLY WELLS, 1950-86, SANTA FE, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06231

GEOHYDROLOGY OF THE REGIONAL AQUIFER SYSTEM, WESTERN SNAKE RIVER PLAIN, SOUTHWESTERN IDAHO.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06257

4C. Effects On Water Of Man's Non-Water Activities

PEELING TWO MISLEADING CONCEPTS OFF THE RATIONAL METHOD.
Ministry of Agriculture, Jerusalem (Israel). Hydrological Service.
For primary bibliographic entry see Field 2E.
W90-05627

URBAN FLOOD RUNOFF MODELING USING MEASURED INFILTRATION CAPACITY OF VARIOUS LAND USES.
Tokyo Metropolitan Univ. (Japan). Dept. of Civil Engineering.
Y. Ando, K. Izumi, M. Morita, and H. Morita.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 130-139, 7 fig, 5 tab, 7 ref, 1 append.

Descriptors: *Rainfall-runoff relationships, *Land use, *Infiltration capacity, *Runoff, *Urban hydrology, *Japan, *Storm runoff, Urban runoff, Model studies, Mathematical studies, Floods, Soil absorption capacity, Kotta River, Hydrographs, Impervious soils.

A flood runoff model was developed for urban basins using measured final infiltration capacities for different land uses. The 12.8 sq km Kotta basin near Tokyo consisted of 21.7% residential area, 8.4% road, 3.1% school, 2.1% park, 51.1% clear land for residence, and 13.6% field and forest. Average infiltration capacities were as follows; sports ground and cleared land, 14 mm/hr; lawn and grass land, 67 mm/hr; slopes beside roads, 281 mm/hr; and field and forest, 696 mm/hr. Median infiltration capacities for the four land uses were 7, 20, 192, and 612 mm/hr, respectively. Relative errors of total runoff in the case of medians and averages were similar, but relative errors of peak runoff in the case of medians (-0.28 to +0.10) were much smaller than those in the case of averages (-.044 to -0.33). Comparison of calculated and observed hydrographs showed that the median final infiltration capacities produced better results than average final infiltration capacities. (See also W90-05621) (Cassar-PTT)
W90-05637

STORM RUNOFF SIMULATIONS IN MATSUYAMA CITY DRAINAGE BASIN.
Kobe Univ. (Japan). Dept. of Agricultural Engineering.
E. Toyokuni, and M. Watanabe.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 146-155, 10 fig, 2 tab, 4 ref.

Descriptors: *Urban runoff, *Rainfall-runoff relationships, *Runoff forecasting, *Storm runoff, *Urban hydrology, *Floods, Matsyama, Japan, Sewers, Storm sewers, Model studies, Mathematical studies, Catchment areas, Storm water, Flood forecasting.

A runoff simulation model incorporates storm water runoff processes in urban drainage basins. The model was applied to data collected from the main sewer drainage area (0.234 sq km) in the Matsuyama, Japan, drainage basin (total area, 6.46 sq km). Impervious surfaces covered 67% of the basin. Data from small scale floods (about 5 mm/hr rainfall and 2.5 cu m/sec peak discharge) and medium scale floods (peak rainfall about 20 mm/hr and peak discharge about 6-7 cu m/sec) were used in the model and the hydrographs compared with observed hydrographs. Results were sufficiently agreeable to be of practical use in predicting runoff. However, less agreement was seen in the hydrographs from the small scale floods. During a heavy rainfall, which reached about 70 mm/hr at times during its 6 hr duration, sewers overflowed and 40 areas were inundated. Results of simulation of this storm showed that the water depth in the main sewer agreed with measured depth. The simulated areas of inundation agreed quite well with those recorded for the actual storm. (See also W90-05621) (Cassar-PTT)
W90-05639

COMPARISON OF RATIONAL AND SCS-TR55 METHODS FOR URBAN STORM WATER MANAGEMENT.
Boswell Engineering, South Hackensack, NJ.
H. Pazwash.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 156-165, 6 fig, 4 tab, 8 ref, 1 append.

Descriptors: *Urban runoff, *Urban hydrology, *Rainfall-runoff relationships, *Runoff forecasting, *Storm runoff, *Rational formula, Kuichling rational method, Soil Conservation Service hydrograph method, Hydrographs, Rainfall, Watersheds, Mathematical studies, Design criteria, Urban watersheds, Water storage.

The runoff hydrographs generated by the rational method, modified rational method and the Soil Conservation Service TR-55 method were compared, using data from an urban watershed. The watershed included commercial development subdivisions and a detention basin for storm water regulation. Storms of 2-, 5-, 25-, and 100-yr return were considered, and hydrographs were calculated for storm durations of 30, 60, 90, and 120 min. The rational method proved useful for the design of storm water drains in urban watersheds. The modified rational method generally was more conservative than the rational method in estimation of runoff volumes. As a result, it was more appropriate than the rational formula for the design of detention basins. The Soil Conservation Service TR-55 method was conservative in predicting peak rate and volume of runoff. Therefore, it was deemed suitable for sizing storm drains and in design of detention facilities. (See also W90-05621) (Cassar-PTT)
W90-05640

NUMERICAL SIMULATION OF TRANSIENT SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-05707

ENGINEERING GEOLOGY OF THE RENO-LAKE TAHOE AREA, NEVADA.
Nevada Bureau of Mines and Geology, Reno.
For primary bibliographic entry see Field 8E.
W90-05736

RIVER DANUBE POLLUTION AND ITS RISK ASSESSMENT.
Benezur U. 28, H-1068, Budapest, Hungary.
For primary bibliographic entry see Field 5B.
W90-05794

DETERMINING REFORESTATION AREA AND DISTRIBUTION FOR SALINITY CONTROL.
Water Authority of Western Australia, Perth. Surface Water Branch.
For primary bibliographic entry see Field 5G.
W90-05835

NORTH SEA BENTHOS: A REVIEW OF FIELD INVESTIGATIONS INTO THE BIOLOGICAL EFFECTS OF MAN'S ACTIVITIES.
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
H. L. Rees, and A. Eleftheriou.
Journal du Conseil-Conseil Internationale Pour l'Exploration de la Mer JCQWAD, Vol. 45, No. 3, 1989. p 284-305, 3 fig, 271 ref.

Descriptors: *Benthos, *Coastal waters, *Environmental impact, *Estuaries, *North Sea, *Water pollution effects, Literature review, Nutrients, Regional variation, Topography.

English-language publications on the benthic fauna of the North Sea were reviewed, with particular reference to those studies aimed at assessing the effects of man's activities. Coverage includes estuaries and coastal waters of the eastern United Kingdom, Belgium, The Netherlands, the Federal Republic of Germany, and the western coastlines of Denmark, Sweden, and Norway, as well as offshore areas. There are regional differences in the amount of evidence available for linking changes in the coastal benthos with anthropogenic influences, reflecting not only differences in the nature and magnitude of activities, but also variations in coastal topography and prevailing hydrographic conditions which may or may not ameliorate the effects. Offshore, the weight of evidence favors the view that no significant benthic changes appear to occur as a result of waste discharge, excepting close to known sources of input, e.g., oil production platforms. However, these changes are very localized and are of little significance relative to the sea area as a whole. Recently, attention has been focused on the possible consequences for the marine ecosystem of an increasing trend of nutrient inputs to certain coastal areas from anthropogenic sources. A persistent concern in benthic studies is the ability to account for, and hence distinguish between, natural effects and those which may be attributable to low-level contamination. This is especially true in inshore environments where marked seasonal or year-to-year changes in abundance and biomass of short-lived species are commonly recorded. In the longer term, benthic communities may also respond to cyclical changes in climate on a variety of time scales. These factors emphasize the general value of extended time-series data in the evaluation of ecosystem changes, and also the importance of 'control' sites in monitoring trends in the biota in relation to contaminant inputs. (Author's abstract)
W90-05874

'MINOR' WETLANDS AS A HABITAT FOR SNIPES IN ITALY: PRESENT SITUATION AND PERSPECTIVES (LE ZONE UMIDE 'MINORI' ITALIANE COME HABITAT PER I BECCACCINI: SITUAZIONE E PROSPETTIVE).
For primary bibliographic entry see Field 2H.
W90-05881

EFFECT OF BOAT MOORINGS ON SEAGRASS BEDS NEAR PERTH, WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Centre for Water Research.
D. I. Walker, R. J. Lukatelich, G. Bastyan, and A. J. McComb.
Aquatic Botany AQBODS, Vol. 36, No. 1, p 69-77, December 1989. 5 fig, 1 tab, 12 ref.

Descriptors: *Anchors, *Australia, *Benthic flora, *Boats, *Coastal waters, *Environmental effects, *Sea grasses, *Vegetation effects, Marine plants, Moorings, Reefs, Scour.

The Perth, Australia metropolitan region has extensive seagrass meadows, situated between the coast and a chain of offshore limestone reefs. Perth also has the highest per capita boat ownership in Australia, and boats are often left moored for long periods. Boat moorings have been found to produce circular scours in seagrass meadows, ranging from 3 to 300 sq m. 'Swing' moorings (with a single anchor and chain) are more damaging than 'Cyclone' moorings (which have three anchors and a swivel) causing scours more than 10 times the area of those created by cyclone moorings. The total area of seagrass meadow lost due to moorings totals some 5.4 ha in the Rottnest Island, Warnbro Sound and Cockburn Sound regions of Western Australia, with most loss (3.14 ha) in the Rottnest region. While the relative area of seagrass meadow lost is small ($< 2\%$), there is considerable visual impact in some areas. The scours created by moorings in the seagrass canopy interfere with the physical integrity of the meadow. Though relatively small areas of seagrass are damaged by moorings, the effect is much greater than if an equivalent area was lost from the edge of a meadow. Damage resulting from moorings could be minimized by discouraging the use of swing moorings and placing moorings only within existing sand patches. (VerNooy-PTT)
W90-05897

GROUNDWATER RECHARGE IN URBAN AREAS.
Birmingham Univ. (England). School of Earth Sciences.
D. N. Lerner.
Atmospheric Environment Part B: Urban Atmosphere AEBAE5, Vol. 24B, No. 1, p 29-33, January 1990. 2 fig, 2 tab, 23 ref.

Descriptors: *Groundwater recharge, *Hydrologic systems, *Leakage, *Urban hydrology, *Water loss, Natural recharge, Seepage loss, Sewer infiltration, Urbanization, Water conveyance.

Urbanization alters all parts of the hydrological cycle so much that no simple analysis of the effects on groundwater is possible. The two interconnected networks of pathways in urban areas are described with particular reference to the links with groundwater. There are the (heavily modified) natural pathways, and the water supply-sewage pathways. As well as reducing direct recharge, urbanization creates new pathways and sources of water for recharge, including leaking water mains, sewers, septic tanks and soakaways. The net effect is often to increase recharge to pre-urbanization rates, or higher in dry climates and cities with high densities and large imported water supplies. Few reliable data are available on urban recharge, either for the individual component or the total, and further scientific and engineering studies are needed. (VerNooy-PTT)
W90-05899

URBAN STREAMS AS A PLACE TO LIVE (STADTBACHE ALS LEBENSRAUM).
Gesamthochschule Essen (Germany, F.R.). Inst. fuer Oekologie.
H. Schuhmacher.
Naturwissenschaften NATWAY, Vol. 76, No. 11, p 505-511, November 1989. 2 fig, 25 ref. English summary.

Descriptors: *Social aspects, *Stream improvement, *Urban hydrology, *Water quality management, Economic aspects, Ecosystems, Soil properties, Wetland restoration.

A historic overview of stream management is presented. Urban streams have been drastically altered, usually not in accordance with modern stream theory. The secondary biotopes of streams, such as standing water and groundwater, are included in a River Continuum Theory. Measures are proposed to meet both human needs and needs for ecological restoration. The problems are complex and require a knowledge of lotic ecology

before resource management decisions can be made. Contamination must be avoided to maintain in the upper course of a stream the uniformly high pH and low nutrient content which correspond to its place in the river continuum. Before uncontrolled disturbance of urban soils a warning is necessary: these soils are still largely unknown regarding many of their natural characteristics, such as their adsorption properties for ions and other compounds. Of equal importance with actions which are good for the water itself, are those for natural habitat development. The restoration of a streamside wetland can run into difficulties greater than land requirements, therefore such remediation can be accomplished only to a small extent in the short term. However, the speedy restoration of extensive riparian wetlands serves not only to produce or increase faunal and floral diversity in congested urban areas, it improves or maintains water quality, restrains floodwaters, improves the urban climate, and increases recreational values. These general effects go hand-in-hand with the economic effect: the ongoing maintenance expenditure for near-natural streams decreases in return for benefits which can scarcely be measured in monetary terms. (Brunone-PTT)
W90-06021

RESOURCE DEVELOPMENT AND CONSERVATION HISTORY ALONG THE OHIO RIVER.
Ohio State Univ., Columbus. School of Natural Resources.
For primary bibliographic entry see Field 6G.
W90-06101

SUSPENDED SEDIMENT AND SEDIMENT-SOURCE AREAS IN THE FOUNTAIN CREEK DRAINAGE BASIN UPSTREAM FROM WIDEFIELD, SOUTHEASTERN COLORADO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2J.
W90-06233

COMPUTERIZED DATA-BASE SYSTEM FOR LAND-USE AND LAND-COVER DATA COLLECTED AT GROUND-WATER SAMPLING SITES IN THE PILOT NATIONAL WATER QUALITY ASSESSMENT PROGRAM.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06234

4D. Watershed Protection

RUNOFF COEFFICIENT AND SEDIMENT YIELD IN SMALL WATERSHEDS UNDER LAND-USE CHANGES IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Dept. of Soil and Water Conservation.
For primary bibliographic entry see Field 2E.
W90-05636

SURFACE RUNOFF FROM TURFED AREA IN THE TROPICS.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 2E.
W90-05654

DESIGN OF ROADSIDE CHANNELS WITH FLEXIBLE LININGS.
Simons, Li and Associates, Inc., Fort Collins, CO.
For primary bibliographic entry see Field 4A.
W90-06184

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

TOXIC ORGANIC COMPOUNDS IN SURFACE SEDIMENTS FROM THE ELIZABETH AND PATAPSCO RIVERS AND ESTUARIES.
Virginia Inst. of Marine Science, Gloucester Point.
R. H. Bieri, C. Hein, R. J. Huggett, P. Shou, and H. Slone.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-134092. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/049A, November 1982. 135p, 69 fig, 7 tab, 8 ref.

Descriptors: *Water pollution, *Estuaries, *Maryland, *Virginia, *Organic compounds, *River sediments, *Patapsco River, *Path of pollutants, *Elizabeth River, Gas chromatography, Estuaries, Mass spectrometry, Aromatic compounds.

This study is an extension of a Chesapeake Baywide analysis of toxic organic substances into the Elizabeth and Patapsco River subestuaries. Twenty-eight surface sediment samples from the Patapsco, were analyzed in detail for the presence of mainly aromatic and polar organic compounds. Approximately 310 distinct compounds were identified by gas chromatography-mass spectrometry in the Elizabeth River samples, and about 480 in the Patapsco. Total aromatic concentrations ranged from 440,000 to 3,100 parts per billion (ppb) in the Elizabeth and from 2,700,000 to 6,100 ppb in the Patapsco. Similar to observations in the Chesapeake Bay, unsubstituted polynuclear aromatic hydrocarbons dominated, contributing about 50% to the total resolved concentration. Both subestuaries must be considered to be severely polluted, and in both there is some evidence of pollutant transport. (Author's abstract)
W90-05750

PRESENT STATE OF MODEL BANK FOR PREDICTING WATER BODY CONDITIONS.
Hydrochemical Inst., Rostov-na-Donu (USSR).
A. M. Nikanorov, A. B. Gortsko, A. A. Matveyev, and M. G. Yereshukova.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 125-149, 2 fig, 27 ref.

Descriptors: *Mathematical models, *Model studies, *Water quality, *Water quality control, *Water quality management, Ecosystems, Mathematical studies, Optimization, Prediction, Simulation analysis.

The basic techniques of mathematical modeling of intrabasin processes within the framework of a determinate approach were examined. Any simulation model, specifically of a body of water, is developed with a specific purpose in mind, which in one way or another is reflected in the model. Simulation models basically serve descriptive or optimization purposes. Basic groups of models, serving various purposes, are: (1) strictly descriptive models--a more precise and efficient data reproduction, including data from field studies; (2) predictive models--rediction of changes in water ecosystem characteristics; and (3) optimization models--selection of optimal strategies of monitoring and control. All models may also be divided into stationary and dynamic, distribution and point, theoretical and empirical, and individual process and ecosystem models. An overview of each of these model classifications and how they can be utilized for the prediction of water body conditions is presented. (See also W90-05772) (Lantz-PTT)
W90-05777

BIOTESTING OF AQUATIC ENVIRONMENTS BASED ON THE BEHAVIORAL REACTIONS OF AQUATIC ANIMALS.
Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.
V. A. Nepomniashchikh, and B. A. Flerov.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 262-282, 7 tab, 16 ref.

Descriptors: *Aquatic animals, *Behavior, *Bioindicators, *Caddisflies, *Leeches, *Toxicity, *Water pollution effects, Aquatic environment, Chlorophos, Feeding, Larvae, Metaphos, Parathion.

Numerous methods are available for testing the effect of water quality on the behavior of aquatic animals. The primary focus is on establishing behavioral indicators of contamination and on forecasting the ecological effect of changes in these indicators caused by poisoning. This article discusses approaches to studying behavior for biotesting and presents the results of experimental work aimed at determining those characteristics in the instinctive behavioral complexes that are both vulnerable to contamination and have a high biological importance. The bulk of this research was conducted using the leech (Hemiclepsis marginata) and caddisfly larvae, by monitoring the following stages in feeding behavior: (1) preparation, (2) attachment, (3) feeding, and (4) satiation. With treatment using the chemical metaphos, ethylparathion, and chlorophos, these behaviors were severely altered indicating that the leeches and the caddisfly larvae were vulnerable to the chemicals. (See also W90-05772) (Lantz-PTT)
W90-05783

QUALITY ASSURANCE GUIDELINES FOR ORGANIC ANALYSIS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. A. Karn, and A. B. Strong.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report EL-89-18, December 1989. Final Report. 80p, 6 tab, 12 ref, append.

Descriptors: *Chemical analysis, *Organic compounds, *Pollutant identification, *Quality control, *Standards, Gas chromatography, Mass spectrometry, Regulations.

The Army Corps of Engineers (CE) is involved with numerous projects that are subject to environmental regulations. To meet the monitoring requirements of these regulations, a number of analytical procedures are used to assess the organic contaminants in environmental samples. Most of the procedures are approved by the US EPA, the American Society for Testing and Materials, or the US Geological Survey. Procedures requiring gas chromatography (GC) or gas chromatography/mass spectrometry (GC/MS) are the most frequently used techniques. Many of the procedures are similar, varying only slightly in sample preparation or quality assurance/quality control (QA/QC) measures. The most commonly used organic analysis procedures and reference sources are summarized in the appendix. The report also provides QA/QC guidance to CE personnel who either perform organic chemical analyses or monitor contractor laboratories. The sequence of events involved with sample analysis is presented from sample handling in the field to the final reporting of data. QA/QC procedures are recommended for every step in the analytical process. Sampling plans, with respect to numbers of samples, site locations, and sampling procedures are not discussed. (Lantz-PTT)
W90-05806

U.S. ENVIRONMENTAL PROTECTION AGENCY'S STRATEGY FOR GROUND WATER QUALITY MONITORING AT HAZARDOUS WASTE LAND DISPOSAL FACILITIES LOCATED IN KARST TERRANES.
Environmental Protection Agency, Washington, DC. Office of Health and Environmental Assessment.

M. S. Field.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-129373. Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/241, November 1988. 6p, 11 ref.

Descriptors: *Groundwater quality, *Hazardous wastes, *Karst hydrology, *Monitoring wells, *Network design, *Waste disposal, Caves, Groundwater movement, Karst, Puerto Rico.

Groundwater monitoring of hazardous waste land disposal units by a network of wells is ineffective when located in karstic terrains. The EPA is proposing to modify its current groundwater quality monitoring requirement of one upgradient well and three downgradient wells for disposal units located in karstic terrains. The convergent nature of subsurface flow to cave streams in karstic terrains requires that effective monitoring wells intercept the cave streams. Wells located around a hazardous waste disposal unit, but not in the specific cave stream draining the site, are only providing irrelevant data and a false sense of security, because the water samples from such wells are not necessarily from the hazardous waste disposal unit. A case study of a landfill in Puerto Rico is provided. EPA is drafting a guidance document that will allow monitoring by wells, only if the up and downgradient wells can be demonstrated to be hydraulically connected by means of dye-trace studies. If not, then the monitoring of springs shown to be hydraulically connected to the facility by dye-tracing studies would be required. Monitoring for sinkhole development will also be required to provide advance warning of sinkhole collapse. The investigation and determination of the probability of sinkhole collapse will be given special treatment. (Author's abstract)
W90-05807

RESEARCH PLAN FOR INTEGRATED ECOSYSTEM AND POLLUTANT MONITORING AT REMOTE WILDERNESS STUDY SITES.
Idaho National Engineering Lab., Idaho Falls. Center for Environmental Monitoring and Assessment.
D. A. Bruns, and G. B. Wiersma.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-015143. Price codes: A04 in paper copy, A01 in microfiche. Report No. EGG-EES--7951, March 1988. 50p, 1 fig, 9 tab, 68 ref. DOE Contract DE-AC07-76-ID01570.

Descriptors: *Monitoring, *Pollutant identification, *Wilderness areas, Catchment areas, Drainage systems, Field tests, Forest watersheds, Research priorities, Water quality.

A plan for measuring pollutants and ecosystem parameters at remote, high-elevation, wilderness study sites proposes a multimedia, systems approach to environmental monitoring. The plan also deals with the field testing and evaluation of several other monitoring approaches to remote areas as developed by the Idaho National Engineering Laboratory (INEL). The work involves multimedia monitoring of trace elements at remote areas, the potential use of portable, real-time gas monitors, the application of stream drainage basin ecosystem parameters, and the analysis of selected forest ecosystem processes potentially sensitive to airborne pollutants. For the purpose of field testing the approaches to monitoring of pollutants and ecosystems in remote, wilderness areas, six evaluation criteria were developed. These criteria are: (1) useability; (2) cost-effectiveness, (3) data variability, (4) alternative approaches, (5) ecosystem conceptual approach, and (6) quality assurance. Both the Forest Service and INEL environmental monitoring techniques will be evaluated with these criteria. Another objective of the research plan is to obtain an integrated database on pollutants and ecosystem structure and function at a remote study site. The methods tested will be used to acquire these data using multimedia monitoring of air and water quality, soils, and forest, stream, and lake ecosystems. (Lantz-PTT)
W90-05810

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM. STATISTICAL AND ANALYTICAL SUPPORT CONTRACT: FINAL REPORT. VOLUME II.
Martin Marietta Environmental Systems, Columbia, MD.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-156657. Price codes: A18 in paper copy, A01 in microfiche. Report No. CBP/TRS 13/87, September 1987. 540p, 4 append.

Descriptors: *Chesapeake Bay, *Monitoring, *Statistical analysis, *Water quality, Ammonium, Chlorophyll a, Density, Dissolved oxygen, Nitrates, Nitrites, Orthophosphorus, Principal component analysis, Salinity, Spatial distribution, Temporal distribution.

Spatial patterns or groupings among mainstem water quality monitoring stations within the Chesapeake Bay mainstem, which capture major regional variations in water quality (Task B) were determined, and temporal groupings among cruises which can be used to identify seasonal and interannual patterns in the data (Task C), were developed. Principal components analysis (PCA) was used to determined the spatial (over stations) and temporal (over cruises) aggregation schemes. Each principal component represents a weighted linear combination of the original water quality variables. The choice of weights (parameter estimates) are determined by an eigenanalysis of the data covariance or correlation matrix. Principal components analyses were performed on surface and bottom, surface only, and bottom only values of subsets of the water quality variables measured. All analyses were performed on the appropriate correlation matrix. With respect to spatial analysis, the first two principal components from a PCA performed on surface and bottom values of all of the water quality variables accounted for 61% of total variation in the data. Salinity and water density were positively correlated with the first components (PC1), while nitrite/nitrate concentrations were negatively correlated with PC1. Water temperature, bottom orthophosphorus, and ammonium concentrations were positively related to PC2. Dissolved oxygen concentrations and bottom chlorophyll-a concentrations were negatively correlated with PC2. With respect to temporal analysis, cruise centroids for the first two components from a PCA of surface and bottom values of all of the water quality variables are shown. The first two components accounted for 61% of the variation observed in the data. PC1 is positively correlated with salinity and water density. PC2 is positively correlated with water temperature and bottom dissolved nutrient concentrations. Distinct seasonal patterns are evident. These seasonal groupings were identified by a visual inspection of the clustering of cruise centroids. Summer conditions are apparent in 1984 (cruises 1 through 7) and 1985 (cruises 22 through 27). Winter conditions are represented by cruises 13 through 17. Two transitional periods, fall 1984 (cruises 8 through 12) and spring 1985 (cruises 18 through 21), are also apparent. (Lantz-PTT)
W90-05811

METABOLISM OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE AQUATIC ENVIRONMENT.
For primary bibliographic entry see Field 5B.
W90-05812

AEROMONAS AND OTHER INDICATOR BACTERIA IN AQUATIC SOURCES IN THAILAND.
International Centre for Diarrheal Disease Research, Dacca (Bangladesh).
Z. Rahim, O. Suthienkul, K. M. S. Aziz, and P. Echeverria.
Bangladesh Journal of Botany BJBTB3, Vol. 18, No. 2, p 197-204, December 1989. 1 fig, 3 tab, 17 ref.

Descriptors: *Bacteria, *Bioindicators, *Coliforms, *Thailand, Aeromonas, Bacterial physiology, Conductivity, Hydrogen ion concentration, Klebsiella, Salinity.

Aeromonas sp., fecal coliforms (FC), and Klebsiella sp. were counted in water samples collected from one lake, three ponds, and six points of the Chao Phraya river passing through three important places of Thailand: Bangkok city, Nonburi and Samutprakan province. Counts of Aeromonas sp., FC and Klebsiella sp., ranged from 1500-26,000, 130-11,000, and 1700-15,000 per 100 ml of water, respectively. Highest Aeromonas sp. and FC counts were recorded in the water samples collected from the Chao Phraya river at the Samutprakan province and from a pond at the National Zoo respectively. Variation of electrical conductivity, pH and salinity was noted in the waters of different sampling sites. The highest salinity 10.3 parts per thousand, pH (7.6) and electrical conductivity (14,000 micro ohm/cm) were recorded in the brackish water of the Chao Phraya river in Samutprakan province. (Author's abstract)
W90-05832

PATHOGENIC AMOEBAE IN NATURAL THERMAL WATERS OF THREE RESORTS OF HIDALGO, MEXICO.
Project of Conservation and Improvement of the Environment, Los Reyes (Mexico). Unit of Interdisciplinary Research of Health and Education Sciences.
For primary bibliographic entry see Field 5B.
W90-05833

AMPEROMETRIC FLOW INJECTION TECHNIQUE FOR DETERMINATION OF HYDROGEN PEROXIDE AND SULFUR(IV) IN ATMOSPHERIC LIQUID WATER.
Sao Paulo Univ. (Brazil). Dept. of Chemistry.
For primary bibliographic entry see Field 7B.
W90-05834

FRESHWATER SEDIMENT TOXICITY BIOASSESSMENT: RATIONALE FOR SPECIES SELECTION AND TEST DESIGN.
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
J. P. Giesy, and R. A. Hoke.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 539-569, 1989. 2 fig, 3 tab, 217 ref. EPA Agreement No. DL 85-002-06.

Descriptors: *Bioassay, *Pollutant identification, *Sediment contamination, *Testing procedures, *Toxicity, Algae, Daphnia, Microtox assay, Midges, Monitoring.

The rationale and conceptual basis for the use of sediment toxicity assays are discussed in relationship to their use in sediment evaluations employing faunal surveys, toxicity assays, and chemical analysis. The disadvantages and advantages of various species from the major classes of aquatic organisms for use as sediment toxicity assay organisms are presented. Relative sensitivities of selected species and their ease of laboratory culture and utility as assay organisms are used to rank assays and propose a battery of assays for the rapid screening evaluation of sediment toxicity. The usefulness of a battery of assays for the screening evaluation of sediment toxicity and statistical considerations which are important in the development of study designs and the analysis of results from the battery of proposed assays are discussed. The assays recommended for inclusion in the screening battery for evaluation of sediment toxicity are Microtox, an algal assay, the Chironomus tentans 10-d growth assay, and the 48-h Daphnia magna acute assay. (Author's abstract)
W90-05842

SOME PROBLEMS AFFECTING THE ASSESSMENT OF GREAT LAKES WATER QUALITY USING BENTHIC INVERTEBRATES.
Waterloo Univ. (Ontario). Dept. of Biology.
D. R. Barton.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 611-622, 1989. 6 fig, 2 tab, 53 ref.

Descriptors: *Benthos, *Bioindicators, *Bottom sampling, *Lake Michigan, *Lake Ontario, *Ma-

croinvertebrates, Data interpretation, Life cycles, Seasonal variation, Substrates, Water quality.

The value of benthic macroinvertebrates as indicators of water quality increases with the understanding of the ways in which environmental and methodological factors can affect the results of field studies. When such factors are taken into account, the benthos accurately reflect changing conditions as demonstrated by long-term studies in southern Lake Michigan and Bay of Quinte, Lake Ontario. However, most studies have employed different field techniques and have been conducted at different times of the year. Some of the effects of such differences are illustrated through analysis of data collected by the Great Lakes Institute (University of Toronto) during the mid-1960s. These and other data suggest that timing of field work will reflect life cycle events such as recruitment, migration, and sexual maturity, all of which influence apparent water quality. Texture of the substratum can have similar effects, but these are not uniform across major taxonomic groups. (Author's abstract)
W90-05847

AQUATIC INSECT ADULTS AS INDICATORS OF ORGANOCHLORINE CONTAMINATION.
Windsor Univ. (Ontario). Dept. of Biology.
Z. E. Kovats, and J. J. H. Ciborowski.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 623-634, 1989. 6 fig, 3 tab, 21 ref.

Descriptors: *Aquatic insects, *Bioaccumulation, *Bioindicators, *Caddisflies, *Mayflies, *Pesticides, Detroit River, Ontario, Polychlorinated biphenyls, Sampling techniques, St Clair River.

The aquatic larval stages of many benthic invertebrates are useful indicators of organochlorine contamination. However, it is often difficult to obtain adequate material for gas chromatographic analysis using benthic sampling methods. Alternatively, one can collect the terrestrial adult stages of aquatic insects. Adult Trichoptera and Ephemeroptera were captured at night at four contaminated sites on the Detroit and St. Clair rivers, and at several uncontaminated central Ontario locations. Modified Pennsylvania style light traps containing dry ice as a killing/preserving agent attracted large numbers of insects. Adult Trichoptera were active throughout the summer, but catches were greatest in late June. Hexagenia (Ephemeroptera: Ephemeridae) abundance was very low except during 2 weeks in late June. Air temperature, wind velocity, and wind direction greatly affected catches. Gas chromatographic analysis of central Ontario samples revealed low but detectable (microg/kg) levels of individual PCB congeners, and relatively high concentrations of some pesticides. Samples weighing 0.75 g dry weight yielded contaminant estimates as precise as larger samples. Neither storage time nor storage temperature influenced analysis. Adult insects collected near the Detroit and St. Clair rivers carried significantly higher body burdens of nearly all contaminants considered than adult insects from central Ontario sites. Spatial pattern of contaminants among insect samples corresponded to that in the sediments. Adult aquatic insects are effective alternatives to immature benthic insects or other invertebrates for preliminary surveys of organic contamination in aquatic habitats. (Author's abstract)
W90-05848

USE OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) TO MONITOR THE NEARSHORE ENVIRONMENT OF LAKES.
University of Western Ontario, London. Dept. of Zoology.
R. H. Green, R. C. Bailey, S. G. Hinch, J. L. Metcalfe, and V. H. Young.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 635-644, 1989. 3 tab, 42 ref.

Descriptors: *Bioindicators, *Environmental effects, *Mollusks, *Monitoring, *Mussels, *Water pollution effects, Lakes, Shell morphology, Transplant experiments.

A combination of observational studies and manipulative field, mesocosm, and laboratory experiments have shown that lentic populations of unionid mussels, in particular Lampsilis radiata and Elliptio complanata, respond to environmental variation in several ways. Thus, mussels may be useful as monitors of their environment. Shell morphology, degree of shell etching, and shell growth rates vary along a gradient of exposure to water energy. These phenotypic responses to environmental variation appear to have little genetic basis. Two polymorphic allozyme loci were examined with electrophoresis, and allelic frequencies showed little spatial pattern. The heritability of shell size and shape was assessed and found to be quite low. However, in transplant experiments mussels moved to different environments were strongly influenced by the environment from which they came. For example, growth rate and tissue metal burdens at the end of a 1-year transplant study are determined much more by the source lake than by destination lake. This 'source effect' can be explained by: (a) slowly reversing acclimation of a common genotype to contrasting habitats (e.g., north shore Lake Erie and adjacent waters), or (b) underlying but as yet undetected genetic differences which are a product of selection in genetically isolated populations (e.g., separate lakes on an acidity gradient in the Muskoka/Haliburton region). Attempts to use contaminant levels in the mussel shell as an environmental monitor were not successful. However, the research does demonstrate that changes in density and growth rate parameters may be attributable to pollution, despite the potentially confounding effects of natural environmental variation. (Author's abstract)
W90-05849

COMPARISON OF LEECHES AND MUSSELS AS BIOMONITORS FOR CHLOROPHENOL POLLUTION.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
J. L. Metcalfe, and A. Hayton.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 654-668, 1989. 6 fig, 4 tab, 31 ref.

Descriptors: *Annelids, *Bioaccumulation, *Bioindicators, *Chlorinated aromatic compounds, *Leeches, *Monitoring, Comparison studies, Fathead minnows, Field studies, Mussels, Ontario.

Leeches were previously shown to have unusually high bioaccumulation capacities for chlorophenols (CPs) and have, therefore, been recommended as biomonitors for CP pollution. To determine whether leeches could survive on-site exposures in cages and to compare leeches and mussels as biomonitors for CPs, two field studies were conducted. CP residues in leeches (Nephelopsis obscura) exposed for 3 weeks above and below a pulp mill complex on the Rainy River, Ontario, were compared with concentrations in resident mussels, while leeches and mussels (Elliptio complanata) were directly compared by exposing them simultaneously in cages near a wood preserving plant on Thunder Bay Harbour. Survival of caged leeches in the Rainy River was excellent (77-87%), provided conductivity/alkalinity was within the tolerance range of the species. Leeches as far as 100 km downstream of the mills accumulated elevated levels of CPs (21-121 ng/g vs. 4-5 ng/g pre-exposure), with proportions of the various congeners reflecting those in mill effluent. Concentrations of CPs in mussels (<0.5-3.5 ng/g) were 1-2 orders of magnitude lower than in leeches. Leeches in Thunder Bay Harbour accumulated four CPs, with concentrations of the dominant pentachlorophenol (PCP) ranging from 817-5,300 ng/g near the plant to 275-375 ng/g at 100 m, 55-85 ng/g at 300 m, and <50 ng/g at 600 m beyond the discharges. In contrast, CPs were never detected in mussels from any site. Bioassays conducted on harbor sediment using fathead minnows (Pimephales promelas), burrowing mayflies (Hexagenia limbata), and leeches demonstrated that uptake and toxicity decreased with increasing distance from the plant. At all sites, PCP residues were similar in field-exposed and lab-exposed leeches. This study demonstrated that leeches are far superior to mussels as biomonitors for CPs, and that leeches can be successfully caged and used in routine monitoring where CP pollution is suspected. (Author's abstract)
W90-05851

USE OF EXPERIMENTAL ECOSYSTEM IN REGULATORY DECISION MAKING.
National Fisheries Contaminant Research Center, Columbia, MO.
T. W. LaPoint, and J. A. Perry.
Environmental Management EMNGDC, Vol. 13, No. 5, p 539-544, September/October 1989. 46 ref.

Descriptors: *Bioassay, *Environmental effects, *Pollutant identification, *Regulations, *Toxicity, *Water pollution effects, Ecosystems, Testing procedures, Tiered testing.

Tiered testing for the effects of chemicals on aquatic ecosystems has begun to include tests at the ecosystem level as a component in pesticide registration. Because such tests are expensive, regulators and industry need to know what additional information they can gain from such tests relative to the costs of the simpler single-species toxicity bioassays. Requirements for ecosystem-level testing have developed because resource managers have not fully understood the implications of potential damage to resources without having evaluations of the predicted impacts under field conditions. Approaches taken in the use of experimental ecosystems, are reviewed, benefits and limitations of small-scale and large-scale ecosystem tests are discussed, and correlative approaches between laboratory and field toxicity testing are pointed out. Laboratory experimental ecosystems (microcosms) have been successfully used to measure contaminant bioavailability, to determine routes of uptake in moderately complex aquatic systems, and to isolate factors modifying contaminant uptake into the biota. Such factors cannot be as readily studied in outdoor experimental ecosystems because direct cause-and-effect relations are often confounded and difficult to isolate. However, laboratory tests can be designed to quantify the relations among three variables: known concentrations of stressors; specific sublethal behavioral, biochemical, and physiological effects displayed by organisms; and responses that have been observed in ecosystem-level analysis. For regulatory purposes, the specificity of test results determines how widely they can be applied. Ecotoxicological research should be directed at attempts to identify instances where single-species testing would be the appropriate level of analysis for identifying critical ecological endpoints and for clarifying relationships between ecosystem structure and function and where it would be inadequate for a given level of analysis. (Author's abstract)
W90-05861

ENVIRONMENTAL MONITORING AT HANFORD, WASHINGTON, USA: A BRIEF SITE HISTORY AND SUMMARY OF RECENT RESULTS.
Battelle Pacific Northwest Labs., Richland, WA. Office of Hanford Environment.
R. H. Gray, R. E. Jaquish, P. J. Mitchell, and W. H. Rickard.
Environmental Management EMNGDC, Vol. 13, No. 5, p 563-572, September/October 1989. 4 fig, 38 ref.

Descriptors: *Fate of pollutants, *Hanford Site, *Monitoring, *Path of pollutants, *Pollutant identification, *Radioactive wastes, *Washington, Environmental impact, Industrial wastes, Mathematical models.

Nuclear and nonnuclear industrial and research activities have been conducted on the Hanford reservation since 1943. Materials originating from these activities may enter the surrounding environment through releases of airborne and liquid effluents and solid wastes. Concern about the environmental effects of these releases has evolved over the past four decades into a comprehensive onsite and offsite monitoring program. Today, environmental monitoring to assess potential impacts of released materials includes field sampling and chemical and physical analysis of air, ground and surface water, fish and wildlife, soil, vegetation, and foodstuffs. This paper reviews the history of Hanford operations and summarizes the current environmental monitoring program and its major findings. Mathematical models based on monitor-

ing data show that radiation doses to people living near the Hanford site are well below existing regulatory standards. Only trace amounts of radionuclides from Hanford have been detected in the offsite environment. (Author's abstract)
W90-05863

REGULATING CONTAMINATED SEDIMENTS IN AQUATIC ENVIRONMENTS: A HYDROLOGIC PERSPECTIVE.
Maryland Univ., College Park. Dept. of Geography.
W. A. Marcus.
Environmental Management EMNGDC, Vol. 13, No. 6, p 703-731, November/December 1989. 4 fig, 34 ref.

Descriptors: *Environmental policy, *Monitoring, *Pollutant identification, *Sediment contamination, Enforcement, Flood plains, Hydrology.

A number of state and federal agencies are attempting to develop management strategies for contaminated aquatic sediments. Research and debate on sediment guidelines and regulations has focused almost exclusively on biological and chemical techniques for determining when sediments pose an environmental risk. Hydrologic factors must also be considered, however, if these biochemically based techniques for establishing sediment quality standards are to be feasible. Hydrologic issues that need to be addressed include how to define the boundaries of the aquatic environment, the scope of sediment regulations in ephemeral water, regulations and sampling procedures in heterogeneous sediment, and timing of samples for monitoring and enforcement purposes. Existing techniques for determining sediment contamination include: (1) the background approach; (2) the partitioning approach; (3) the interstitial water approach; and (4) biological sampling approaches. No one of the approaches is clearly superior. It is likely that several of the approaches will be used for any one assessment depending on the depositional environments. It is further suggested that the boundaries of the aquatic environment be defined for regulatory purposes to include intermittently inundated areas, as well as permanently flooded sediments. (Author's abstract)
W90-05865

METHOD FOR ANALYSIS OF BUTYLTIN SPECIES AND MEASUREMENT OF BUTYLTINS IN SEDIMENTS AND ENGLISH SOLE LIVERS FOR PUGET SOUND.
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
C. A. Krone, D. W. Brown, D. G. Burrows, R. G. Bogar, and S.-L. Chan.
Marine Environmental Research MERSDW, Vol. 27, No. 1, p 1-18, 1989. 1 fig, 4 tab, 39 ref.

Descriptors: *Antifoulants, *Bioaccumulation, *Marine sediments, *Organotin compounds, *Pollutant identification, Extraction techniques, Sediment contamination, Sole, Tissues.

A method for determining tetra-, tri-, di-, and monobuytltin in marine sediments and in tissues from English sole was developed. The method utilized dichloromethane/tropolone extraction of the butyltins, derivatization with hexylmagnesium bromide, and a silica/alumina column cleanup prior to gas chromatographic/mass spectrometric (GC/MS) analysis. A number of quality assurance measures were incorporated in the method. Mean recoveries of the surrogate spike tripentyltin from sediment and tissue reference materials ranged from 96% to 110%. The method was applied to sediments and livers of English sole collected in Puget Sound, Washington state. Total butyltin concentrations in sediments ranged from < 5 to 1900 ng/g dry weight as Sn. Tributyltin concentrations of > 1000 ng/g were found in some sediments. Butyltins were also determined in livers from English sole captured at sites where sediments were contaminated with butyltins. Dibutyltin (at concentrations up to 870 ng/g dry weight as Sn) was the predominant butyltin species found in the livers. (Author's abstract)
W90-05875

LANTHANIDE LUMINESCENCE QUENCHING AS A DETECTION METHOD IN ION CHROMATOGRAPHY: CHROMATE IN SURFACE AND DRINKING WATER.
Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.
For primary bibliographic entry see Field 7B.
W90-05913

DETERMINATION OF ORGANIC AND INORGANIC ACIDS IN PRECIPITATION SAMPLES.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
V. Cheam.
Journal of Chromatography JOCRAM, Vol. 482, No. 2, p 381-392, December 1, 1989. 5 fig, 8 tab, 29 ref.

Descriptors: *Acid rain, *Atmospheric chemistry, *Chemistry of precipitation, *Inorganic acids, *Laboratory methods, *Organic acids, *Pollutant identification, *Precipitation, Chemical analysis, Chromatography, Detection limits, Natural waters, Water sampling.

While inorganic acids continue to be very important constituents in acid rain studies, organic acids are becoming more and more a prerequisite for proper accounting of atmospheric chemistry processes and precipitation ionic balances. An ion chromatographic method is described for simultaneous analysis of major organic and inorganic acids (formic, acetic, nitric, sulfuric, hydrochloric and hydrofluoric) in precipitation samples. The method can also determine several other acids commonly cited in literature on precipitation-related samples; namely, propionic, glycolic, butyric, methanesulfonic, nitrous, hydroxymethylsulfonic, oxalic, phosphoric and citric acids. The method can be adapted for routine analysis of these acids, which are resolved in less than 10 minutes. Three types of natural waters were analyzed: a rain sample, a Eulerian quality control sample, and an rain-snow mixture which was immediately preserved with 0.2% chloroform. Sixty recoveries were made giving a percent recovery range of 90 to 110%. (Author's abstract)
W90-05914

SPECTROPHOTOMETRIC FIELD MONITOR FOR THE DETERMINATION OF NITRATE IN RIVER WATER: STATISTICAL ANALYSIS OF THE RESULTS FROM A NINE-MONTH FIELD TRIAL.
Freshwater Biological Association, Wareham (England). River Lab.
For primary bibliographic entry see Field 7B.
W90-05936

HUMIC AND OTHER NEGATIVELY CHARGED COLLOIDS OF IRON AND COPPER IN RIVER WATER.
Nagoya Univ. (Japan). Faculty of Engineering.
For primary bibliographic entry see Field 2K.
W90-05937

FRESHWATER FISH CYTOCHROME P450-DEPENDENT ENZYMATIC ACTIVITIES: A CHEMICAL POLLUTION INDICATOR.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon (France). Lab. d'Ecotoxicologie.
E. Vindimian, and J. Garric.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 3, p 277-285, December 1989. 6 fig, 2 tab, 19 ref.

Descriptors: *Bioindicators, *Cytochromes, *Fish physiology, *Pollutant identification, *Water pollution effects, Enzymes, Factor analysis, Mathematical studies, Mixed function oxidases, Regression analysis.

Mixed function oxidase activities of fish liver homogenates were measured during four sampling campaigns (March 1986, October 1986, June 1987 and December 1987) in the river Durance in the southeast of France. Six hundred fish belonging to four species were caught for this study; the use of factorial analysis emphasized the strong pollution dependence of the P450-dependent enzymatic activities which vary with the season, the species, and the sex of the fish. Species can be ordered according to decreasing aryl hydrocarbon hydroxylase (AHH) values as follows: Leuciscus cephalus, Chondrostoma nasus, Barbus barbus, and Nemacheilus barbatulus. Males had higher AHH activities than females. Higher activities in March than in June or October were noted. Regression analysis of the data allowed prediction of the type of location from which the fish came (polluted or unpolluted) for 80% of the fish. This supports use of such activities as chemical pollution indicators. (Geiger-PTT)
W90-05942

PLANARIANS IN TOXICOLOGY: I. PHYSIOLOGY OF SEXUAL-ONLY DUGESIA DOROTOCEPHALA: EFFECTS OF DIET AND POPULATION DENSITY ON ADULT WEIGHT AND COCOON PRODUCTION.
Illinois Univ. at Urbana-Champaign. Dept. of Veterinary Biosciences.
J. Kostelecky, B. Elliott, and D. J. Schaeffer.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 3, p 286-295, December 1989. 1 fig, 3 tab, 42 ref.

Descriptors: *Bioindicators, *Platyhelminthes, *Pollutant identification, *Toxicology, Diets, Growth, Population density, Statistical analysis.

A rare sexual-only race of Dugesia dorotocephala produces offspring from cocoons rather than by fissioning, allowing individuals to be accurately aged. Because each animal possesses fully developed male and female reproductive systems and a true brain with synapses, many types of toxicological studies which normally use vertebrates are possible with these animals. Because these animals are very sensitive to low concentrations of environmental toxicants, they have been used in Europe for decades to detect pollutants in water. Prior to using this race for toxicological studies, a factorial study was carried out to determine the effects of environmental conditions on reproduction and growth. The factors studied were crowding (2, 4, or 8 animals/50 ml medium), age (17, 19, 21 mo), and type of dietary protein (soy, liver, cooked egg yolk). Protein composition dramatically affected the numbers of cocoons deposited per planarian, mean weight, and temporal patterns of weight changes. During 65 days of observation, planarians fed liver deposited an average of 3.28 cocoons/planarian while those fed soya or egg yolk deposited an average of 0.25 cocoon/planarian. Crowding, but not age, affected the numbers of cocoons deposited. Statistical analysis showed that protein composition, age, and crowding, alone and in factorial combinations, affected both the absolute weight changes and the temporal patterns in weight changes in each group. (Author's abstract)
W90-05943

ECOTOXICOLOGICAL CHARACTERIZATION OF INDUSTRIAL WASTEWATER: SULFITE PULP MILL WITH BLEACHING.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W90-05945

SPECIATION OF ORGANOTIN COMPOUNDS IN WATER BY GAS CHROMATOGRAPHY/ATOMIC ABSORPTION SPECTROMETRY.
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
W. M. R. Dirkx, W. E. Van Mol, R. J. A. Van Cleuvenbergen, and F. C. Adams.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 335, No. 7, p 769-774, December 1989. 4 fig, 7 tab, 26 ref.

Descriptors: *Antifoulants, *Atomic absorption spectrophotometry, *Gas chromatography, *Organotin compounds, *Pesticides, *Pollutant identification, Biocides, Speciation, Water analysis.

A reproducible and interference-free method is presented for simultaneous determination of individual tri-, di-, and monoalkyltin species present in aqueous systems. The ionic methyltin and butyltin compounds are extracted from water into pentane as diethyldithiocarbamate complexes at pH 5. The organic phase is then evaporated to dryness under reduced pressure, after which derivatization with n-pentyl (Pe) Grignard reagent is carried out in a microvolume of n-octane to form pentylated alkyltin compounds R(n)SnPe(4-n) where R = methyl or butyl. The quantitation is subsequently performed by gas chromatography with quartz furnace atomic absorption spectrometric detection. Absolute detection limits range between 0.16 nanograms and 0.40 nanograms Sn for the various organotin species, allowing speciation in natural water down to the 4-10 nanogram/L level. (Author's abstract)
W90-05946

SEPARATE DETERMINATION OF ORGANIC HALOGEN OR SULPHUR COMPOUNDS IN WATER AFTER ADSORPTION ON CHARCOAL AND STEPWISE PARTIAL THERMAL DESORPTION (GETRENNTE BESTIMMUNG VON ORGANISCHEN HALOGEN ODER SCHWEFELVERBINDUNGEN IN WAESSERN NACH ADSORPTION AN AKTIVKOHLE UND SCHRITTWEISER PARTIELLER DESORPTION).
Muenster Univ. (Germany, F.R.). Anorganisch-Chemisches Inst.
A. Essing, and F. Umland.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 335, No. 7, p 826-832, December 1989. 11 fig, 5 tab, 7 ref. English summary.

Descriptors: *Electrical studies, *Halogenated hydrocarbons, *Organic compounds, *Pollutant identification, *Sulfur compounds, Absorption, Charcoal, Desorption, Separation techniques.

A method is described for the separation of mixtures of halogenated hydrocarbons, adsorbed on charcoal, by controlled thermal desorption. In a second step the desorbed species are burned. The generated halogenide ions are determined coulometrically. The method was applied to real water samples. It can also be applied to determine organic thiocompounds. Thiobenzamide and 2-mercaptoethanol were used as model substances. (Author's abstract)
W90-05947

DISTRIBUTION OF (C14)ACRYLAMIDE IN RAINBOW TROUT STUDIED BY WHOLE-BODY AUTORADIOGRAPHY.
Louisville Univ., KY. Dept. of Pharmacology and Toxicology.
For primary bibliographic entry see Field 5B.
W90-05948

CHEMICAL DERIVATIZATION ANALYSIS OF PHENOLS: PART VI. DETERMINATION OF CHLORINATED PHENOLICS IN PULP AND PAPER EFFLUENTS.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
H.-B. Lee, R. L. Hong-You, and P. J. A. Fowlie.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 72, No. 6, p 979-984, November/December 1989. 4 fig, 5 tab, 16 ref.

Descriptors: *Gas chromatography, *Phenols, *Pollutant identification, *Pulp wastes, Bleaching wastes, Separation techniques, Spectral analysis, Wastewater analysis.

Based on the in-situ acetylation procedure, a method for the determination of 31 chlorinated phenols, guaicols, catechols, syringols, and vanillins in pulp and paper effluent samples has been successfully developed. Except for 4-chlorocatechol, this procedure provided satisfactory recovery for all phenols at 3 levels of fortification, namely, 400, 40, and 4 micrograms/L. The acetyl derivatives were analyzed by gas chromatography using a 30 m DB-5 capillary column interfaced to an electron-capture detector. Mass spectral abundance data for the characteristic ions of the acetyl derivatives were used for confirmation of compound identities. By operating a mass selective detector in the selected ion monitoring mode, this procedure was further extended to the monochlorinated phenolics. Using a 50 mL effluent sample, the method detection limit was 0.5 micrograms/L for all except the monochlorinated compounds, which had a detection limit of 1 microgram/L. Several effluent samples from a Canadian paper mill were analyzed to validate the procedure. (Author's abstract)
W90-05952

EVALUATION OF GROWTH MEDIA FOR THE RECOVERY OF ESCHERICHIA COLI FROM OZONE-TREATED WATER BY MEMBRANE FILTRATION.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
G. R. Finch.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 4, p 383-390, 1989. 2 tab, 18 ref. Alberta Environmental Research Trust Grant T0937. Natural Sciences and Engineering Research Council of Canada Grant A01010.

Descriptors: *Bioindicators, *Coliforms, *Escherichia coli, *Membrane filters, *Ozonation, *Pollutant identification, Culture media, Growth media, Ozone.

The standard membrane filtration methods for total coliforms and fecal coliforms were evaluated for their ability to recover injured E. coli ATCC 11775, from ozone-treated water. m-T7 Agar was considered as an alternative growth medium at 35 C and 44.5 C. Seven batch experiments revealed that m-T7 agar recovered significantly (Pr $<$ or = 0.05) more E. coli than Standard Methods at each incubation temperature. m-T7 Agar incubated at 35 C had the best overall recovery of ozonated E. coli. The results were consistent with other reports in the literature regarding the inadequacy of standard selective growth media for the enumeration of injured coliform bacteria in water. (Author's abstract)
W90-05973

AUTOMATIC MONITORING OF SHORT DURATION SNOWMELT EVENTS IN A NOVA SCOTIA HEADWATER STREAM.
Inland Waters Directorate, Moncton (New Brunswick). Water Quality Branch.
For primary bibliographic entry see Field 7B.
W90-05987

USE OF SELENASTRUM CARPICORNUTUM AND MICROFEAST AS FOOD FOR DAPHNIA PULEX.
North Texas State Univ., Denton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-06037

RAPID DETECTION OF SUBLETHAL TOXICITY USING FISH VENTILATORY BEHAVIOR.
Biological Monitoring, Inc., Blacksburg, VA.
J. M. Diamond, M. J. Parson, and D. Gruber.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 3-11, 1990. 5 fig, 3 tab, 32 ref. NIH Grant 1R4ESO3808 and NSF Grant ISI-8503191.

Descriptors: *Bioindicators, *Gills, *Heavy metals, *Pesticide toxicity, *Sublethal effects, *Sunfish, *Toxicity, *Ventilation, Bioassay, Cadmium, Chlorinated hydrocarbons, Dieldrin, Fish toxins, Water pollution effects, Zinc.

Significant changes in bluegill sunfish ventilation were observed at chronically toxic levels of various substances in under 1 hour of exposure and usually within 15 minutes of exposure. Fish were exposed in flow through chambers to concentrations of either zinc sulfate (400 ppb zinc), cadmium chloride (4.0 micrograms/L Cd), trichloroethylene (24 ppb) or dieldrin (27 ppb). A different ventilation response was observed between the heavy metal compounds and the chlorinated hydrocarbon substances. The response to zinc and cadmium was characterized by decrease in signal amplitude and increase in Type I (large volume) coughs of gill purges. The response to chlorinated hydrocarbons was characterized by increases in erratic movement, gill purges and ventilatory frequency. Our results suggest that fish ventilatory monitoring can provide a powerful tool for rapidly assessing sublethal as well as acute toxicity on a real-time basis. Furthermore, the type of response generated may be indicative of the type of toxicant in the environment. (Author's abstract)
W90-06044

BEHAVIORAL SCREENING ASSAY FOR DAPHNIA MAGNA: A METHOD TO ASSESS THE EFFECTS OF XENOBIOTICS ON SPACIAL ORIENTATION.
NIEHS Marine and Freshwater Biomedical Core Center, Milwaukee, WI.
M. S. Goodrich, and J. J. Lech.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 21-30, 1990. 5 fig, 4 tab, 32 ref. NIH Grant ES01080 and Grant ES04184.

Descriptors: *Animal behavior, *Bioassay, *Bioindicators, *Daphnia, *Lindane, *Sublethal effects, *Water pollution effects, Light intensity, Migration, Spatial distribution, Statistical analysis, Toxicity, Toxins.

A short-term, low-cost method of detecting changes in the orienting ability of Daphnia magna in response to xenobiotics employs the reaction (migration along the gradient) of L. magna to a light intensity gradient. The method was derived from techniques established to simulate and analyze migration patterns of zooplankton in the natural environment. Each test uses a minimum of 100 1 to 3 day old Daphnia exposed to a directional light beam within a circular chamber. The chamber is divided into eight sections, each containing 45 degrees of arc. These quadrants can be isolated from each other, thus isolating eight groups of migrating Daphnia. Each test results in three endpoints: an average direction for the migration (mean angle), an index of the magnitude of random, undirected migration (r value) and a percentage of nonresponse. The method was validated by showing a positive dose-related response to a known neurotoxin, lindane. The method is sensitive to lindane, producing effects on orientation even at a concentration as low as 50 ppb. The effect of lindane was a dramatic increase in the random migration of dosed Daphnia, showing a less directed migration pattern than control. The incorporation of this type of test into a general toxicity screening of a xenobiotic in Daphnia can make use of the excess offspring in brood stocks in a sublethal behavioral assay. Results of the assay could be used to determine possible modes of toxicity. (VerNooy-PTT)
W90-06046

BEHAVIORAL TOXICITY SYNDROMES: A PROMISING TOOL FOR ASSESSING TOXICITY MECHANISMS IN JUVENILE FATHEAD MINNOWS.
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5C.
W90-06048

FISH BEHAVIOR AND ENVIRONMENTAL ASSESSMENT.
Battelle Pacific Northwest Labs., Richland, WA.
R. H. Gray.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 53-67, 1990. 11 fig, 1 tab, 68 ref. DOE DE-AC06-76RLO-1830.

Descriptors: *Avoidance, *Bioindicators, *Environmental quality, *Fish behavior, *Tracking techniques, *Water pollution effects, Bullhead, Carp, Coal wastes, Fish migration, Minnow, Salmon, Supersaturation, Tagging, Telemetry, Thermal pollution, Trout, Water quality.

Studies at the Pacific Northwest Laboratory have evaluated fish behavior and migration in response to gas-supersaturated water, thermal discharge, water-soluble fractions (WSFs) of coal liquids and other environmental stresses. Approaches have included biotelemetry in the field, and avoidance/attraction and predator/prey studies in the laboratory. This article specifically addresses three study examples and integrates the results with those of related studies. Overall, major findings included the following: thermal discharges (surface water temperature changes from 0 to less than 17 C) did not block upstream migration of sonic-tagged adult chinook salmon (oncorhynchus tschawytscha) and rainbow trout (O. mykiss, formerly Salmo gairdneri) in the Hanford Reach of the Columbia River. Juvenile chinook salmon avoided thermal discharges in the laboratory when temperature changes exceeded 9 to 11 C above ambient. However, juvenile salmon were more susceptible to predation at 10 to 20% of the thermal dose than in normally saturated water in the Snake River and, thereby, avoided the upper, critical zone. Carp (Cyprinus carpio) and black bullhead (Ictalurus melas) did not always avoid lethal gas levels in the laboratory and some fish died in the test apparatus. Fathead minnow (Pimephales promelas) avoided the WSF of a coal liquid at concentrations causing acute effects but not at those causing chronic effects. Rainbow trout did not avoid coal liquid WSFs although they reportedly avoid the major constituent, phenol, tested as a pure compound. Susceptibility to predation of juvenile rainbow trout did not increase until phenol concentrations reached the acute LC50 (concentration lethal to half of the group). A conceptual model has been developed to link avoidance and toxicological data for environmental assessment is presented. (Author's abstract)
W90-06050

BEHAVIORAL RESPONSES OF MARKED SNAILS AS INDICATORS OF WATER QUALITY.
Jordan (Edward C.) Co., Inc., Wakefield, MA.
J. A. Burris, M. S. Bamford, and A. J. Stewart.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 69-76, 1990. 5 fig, 4 tab, 16 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Animal behavior, *Bioindicators, *Migration, *Snails, *Stream pollution, *Water quality, Behavior, Bioassay, Chlorine, In situ tests, Monitoring, Sublethal effects, Toxicity, Water pollution effects.

Behavioral responses of the common stream-dwelling operculate snail Elimia clavaeformis were used to provide information about streamwater quality in in situ tests. These snails were found to be advantageous for such tests because they can be collected easily, individually marked, and transferred to other stream sites for release and recapture experiments. In noncontaminated stream sites, Elimia tended to disperse upstream. The rate of net movement was variable, but typically ranged from 0.5 to 5 meters/day. Water velocity and food level influenced the movement patterns of the snails in 24 and 48 hour field experiments in noncontaminated stream sites. Rates of movement in the laboratory were temperature dependent, and increased from about 1.0 cm/minute at 9 C to 2.2 cm/minute at 24 C. In contaminated streams, snails showed clear evidence of stress: They moved downstream, and in some sites either withdrew into the shell or were unable to retract the foot or attach to a substrate. The maximum distance that Elimia traveled downstream in 24 hours in a contaminated stream site was 17.5 meters. In laboratory streams, Elimia moved downstream when exposed to 0.02 mg/L total residual chlorine (TRC); the time required to immobilize these snails declined rapidly as TRC concentration increased. Behavioral characteristics of snails that may be useful for water quality assessments include turnover time (the time needed for a snail to right itself after being turned onto its back), the rate and direction of dispersal or immobilization. (Author's abstract)
W90-06051

EVALUATION OF THE SPECIATION OF INORGANIC CONSTITUENTS IN SEDIMENTS OF THE RESERVOIR AT ALTENWORTH OF THE RIVER DANUBE.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
For primary bibliographic entry see Field 5B.
W90-06061

ASSESSING RIVER WATER QUALITY BY MEANS OF MULTIFACTORIAL METHODS USING MACROINVERTEBRATES. A COMPARATIVE STUDY OF MAIN WATER COURSES OF BISCAY.
Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.
T. Bargos, J. M. Mesanza, A. Basaguren, and E. Orive.
Water Research WATRAG, Vol. 24, No. 1, p 1-10, January 1990. 5 fig, 2 tab, 27 ref.

Descriptors: *Bioindicators, *Biological studies, *Macroinvertebrates, *Pollutant identification, *Spain, *Statistical analysis, *Water pollution effects, *Water quality, Biscay, Eutrophication, Seasonal variation, Wastewater disposal.

Ninety-two taxa of benthic macroinvertebrates were used to study water quality at 175 sites from main water courses of Biscay (Basque Country) Spain by means of correspondence analysis (CA). The most abundant taxa were Oligochaeta, Chironomidae, Baetidae, Simuliidae and the mollusc Potamopyrgus jenkinsi. On the plane of the first two axes from CA, changes in macroinvertebrate community structure were observed between rivers due to differences in natural eutrophication and as a result of the combined effect of industrial and urban sewage. The groups of taxa observed could be interpreted in ecological terms and were representative of headwater reaches, moderately eutrophic waters and polluted waters. This method of ordination provides more information on differences in water quality among the non-polluted sites than does a biotic index. (Author's abstract)
W90-06066

RESULTS OF THE HARMFUL EFFECTS OF WATER POLLUTANTS TO GREEN ALGAE (SCENEDESMUS SUBSPICATUS) IN THE CELL MULTIPLICATION INHIBITION TEST.
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 5C.
W90-06069

OCCURRENCE OF THERMOPHILIC CAMPYLOBACTERS IN RURAL AND URBAN SURFACE WATERS IN CENTRAL FINLAND.
National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology.
For primary bibliographic entry see Field 5B.
W90-06077

COLIPHAGES AS AN INDICATOR OF FAECAL POLLUTION IN WATER. THEIR SURVIVAL AND PRODUCTIVE INFECTIVITY IN NATURAL AQUATIC ENVIRONMENTS.
Malaga Univ. (Spain). Dept. of Microbiology.
J. J. Borrego, R. Cornax, M. A. Morinigo, E. Martinez-Manzanares, and P. Romero.
Water Research WATRAG, Vol. 24, No. 1, p 111-116, January 1990. 4 fig, 30 ref.

Descriptors: *Bioindicators, *Fecal coliforms, *Monitoring, Aquatic environment, Bacteria, Escherichia coli, Microbiological studies.

The capability of coliphages as indicators of fecal pollution was tested, on the basis of their survival and infectivity in two natural organic aquatic environments (marine and river). The results obtained indicate that coliphages show a similar inactivation rate to Salmonella in all types of water studied. On the other hand, the phage productive infection of Escherichia coli cells in water and environmental conditions depends on the physiological characteristics of the host bacteria, which generally cannot grow optimally in these conditions. Therefore, coliphages may be considered good indicators of fecal pollution in natural waters. (Author's abstract)
W90-06080

RELATIONSHIPS BETWEEN SALMONELLA SPP AND INDICATOR MICROORGANISMS IN POLLUTED NATURAL WATERS.
Malaga Univ. (Spain). Dept. of Microbiology.
M. A. Morinigo, R. Cornax, M. A. Munoz, P. Romero, and J. J. Borrego.
Water Research WATRAG, Vol. 24, No. 1, p 117-120, January 1990. 3 tab, 26 ref. WHO Project SPA-D-26.

Descriptors: *Bioindicators, *Monitoring, *Pathogenic bacteria, *Salmonella, Fecal coliforms, Wastewater pollution, Water quality control.

The relationships between Salmonella spp and indictor microorganisms (total coliforms, fecal coliforms, fecal streptococci, Clostridium perfringens and coliphages) were investigated in three different aquatic environments affected by wastewater discharges. The results indicated that the statistical correlations obtained depended, basically, on the source of fecal discharges. The microorganisms most closely correlated with Salmonella spp were fecal coliforms and C. perfringens, the latter also yielding the highest linear regression slope values. The detection percentages of Salmonella spp were high even at a low degree of pollution, which allowed detection of the pathogens in the absence of classical indicator microorganisms in the sample. (Author's abstract)
W90-06081

WATER QUALITY IN RIVERS OF WESTERN SWITZERLAND: APPLICATION OF AN ADAPTABLE INDEX BASED ON BENTHIC INVERTEBRATES.
Conservation de la Faune, Saint-Sulpice (Switzerland).
C. Lang, G. l'Eplattenier, and O. Reymond.
Aquatic Sciences AQSCEA, Vol. 51, No. 3, p 224-234, 1989. 4 fig, 5 tab, 13 ref, append.

Descriptors: *Benthic fauna, *Bioindicators, *Data acquisition, *Pollutant identification, *Rivers, *Switzerland, Aquatic insects, Cluster analysis, Invertebrates, Pollution index, Water quality management.

Water quality was estimated from 205 samples of benthic invertebrates collected between 1983 and 1986 in 51 rivers of western Switzerland (Canton of Vaud). Each sample consisted of the combined list of taxa resulting from one spring sample pooled with one summer sample. Water quality was indicated by total number of taxa and number of taxa intolerant of pollution: i.e. Heptageniidae, Plecoptera, and Trichoptera with a case. Six classes of values were delimited for each of these two variables by cluster analysis. Values from zero to five were attributed to each class. The index of water quality was computed by adding these two values in each sample. According to this index, good water quality water indicated by 42% of samples. This index can be adapted to other rivers because its components are easily modified. (Author's abstract)
W90-06087

ECOLOGY OF CILIATES IN RIVERWATERS: THE EVALUATION OF WATER QUALITY VIA CILIATES AND FILAMENTOUS BACTERIA.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
F. Stoessel.
Aquatic Sciences AQSCEA, Vol. 51, No. 3, p 235-248, 1989. 7 fig, 19 ref.

Descriptors: *Bioindicators, *Data acquisition, *Filamentous bacteria, *Pollutant identification, *Protozoa, *Rivers, Microbiological studies, Periphyton, Species composition, Switzerland, Water quality management.

Since sewage treatment plants are quite effective in Switzerland, the micro-benthic communities in receiving running waters have changed consider-

ably. From January 1980 to September 1981 the periphyton communities in 13 Swiss streams and rivers were investigated monthly. The ammonium nitrogen concentration in these waters varied between 0.015 and 1.0 mg/L. Four typical communities of microorganisms were found: (1) in unpolluted running waters mainly small vagile ciliates were abundant; (2) In slightly polluted waters peritricha (in the presence of bacteria) were found; (3) in moderately polluted waters peritricha in combination with a few hymenostomata and Sphaerotilus could grow when bacteria and some degradable organic material were present; and (4) in polluted waters the well-known Spaerotilus community could be found. The microscopic as well as the macroscopic aspect should be considered when estimating the degree of pollution in streams and rivers. (Author's abstract)
W90-06088

NON-VOLATILE CHEMICAL MUTAGENS IN SEDIMENTS OF THE KANAWHA RIVER, WEST VIRGINIA.
Marshall Univ., Huntington, WV. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W90-06105

LEAKY FILTERS: A WARNING TO AQUATIC ECOLOGISTS.
Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.
For primary bibliographic entry see Field 7B.
W90-06110

EFFECTIVENESS OF AGRICULTURAL AND SILVICULTURAL NONPOINT SOURCE CONTROLS.
Jones and Stokes Associates, Inc., Bellevue, WA.
For primary bibliographic entry see Field 5G.
W90-06175

HEALTH AND ENVIRONMENTAL CHEMISTRY: ANALYTICAL TECHNIQUES, DATA MANAGEMENT, AND QUALITY ASSURANCE.
Los Alamos National Lab., NM.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-006697. Price codes: A06 in paper copy, A01 in microfiche. Report No. LA--10300-M-Vol. 2, September 1988. 124 p. Edited by Margaret A. Gautier and Ernest S. Gladney.

Descriptors: *Analytical techniques, *Chemical analysis, *Quality control, *Wastewater analysis, *Water analysis, Colorimetry, Gravimetry, Monitoring, Potentiometry, Radiochemical analysis, Spectral analysis, Titrimetry, Water quality control.

This manual has been prepared to document the analytical methodology used by the Los Alamos National Laboratory Health and Environmental Chemistry Group. It is part of the overall quality control effort to support the health, safety, and environmental programs at the Laboratory. This section provides analytical methods for the monitoring of waste discharges under the National Pollutant Discharge Elimination System. The analytical procedures were developed by the Health and Environmental Chemistry staff. They were modified from standard methods developed and evaluated by the Environmental Protection Agency (EPA), or were adapted from procedures found in the literature. The procedures have been tested by chemists and technicians to prove their validity, and include: atomic absorption, colorimetry, gravimetry, potentiometry, titrimetry, and radiochemistry. The methods measure the concentration of the desired analytes with the precision, accuracy, and specificity required by Group HSE-7, Waste Management, and meet the needs of federal legislation. The procedures utilize equipment and skills available in modern wastewater chemistry laboratories. Precision procedure is presented in a simple and concise manner and includes interferences, apparatus, reagent preparation, calibration methods, and data reduction formulas. (Author's abstract)
W90-06190

IN SITU DETECTION OF ORGANIC MOLECULES.
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
S. M. Angel, K. C. Langry, T. J. Kulp, P. F. Daley, and D. J. Bishop.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-016646. Price codes: A03 in paper copy, A01 in microfiche. Report No. UCRL-21081, August 15, 1988. 41p, 35 fig, 2 tab, 24 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Chloroform, *Groundwater pollution, *In situ tests, *Pollutant identification, *Trichloroethylene, Chlorinated hydrocarbons, Fluorescence, Monitoring.

A new fluorescence-based chemical indicator has been developed for detecting chloroform and trichloroethylene. The fluorescent products resulting from this assay using modern spectroscopic techniques have been isolated and identified. In this report, the details of this reaction, its putative reaction sequences with chloroform and trichloroethylene, are described, and an analysis of the spectral data obtained from the reaction products is given. Preliminary measurements are made using a fiber optic chemical sensor (optrode) for monitoring groundwater contamination that exploits this new fluorescence-based indicator for chloroform and trichloroethylene. Details of the sensor configuration and the chemical reagents employed in the transduction chemistry are reported. A technique was developed for this optrode that permits the selective detection of chloroform in the presence of trichloroethylene, and discusses approaches to selectively measure trichloroethylene in the presence of chloroform. The results of preliminary measurements of trichloroethylene with optrodes that contain the new chemical indicator are outlined in this report. Syntheses of several compounds are evaluated to improve the luminescence properties of the fluorescence-based test for chloroform and trichloroethylene. (Lantz-PTT)
W90-06201

GROUNDWATER CHEMICALS DESK REFERENCE.
J. H. Montgomery, and L. M. Welkom.
Lewis Publishers, Inc., Chelsea, MI. 1990. 640 p.

Descriptors: *Chemical properties, *Groundwater pollution, *Pollutant identification, *Priority pollutants, Data collections.

Information is compiled on more than 135 compounds that may be groundwater pollutants. The compounds profiled include all the Priority Pollutants promulgated by the U.S. EPA under the Clean Water Act (CWA) of 1977. Many of these priority pollutants were included among the Target Compounds promulgated by the EPA under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986. All chemicals described in the book are classified as priority pollutants and/or target compounds. For each chemical, the following information is given: (1) synonyms; (2) structural formula; (3) CAS Registry number; (4) DOT designation; (5) empirical formula; (6) formula weight; (7) RETCS number; (8) physical and chemical properties; (9) fire hazards; (10) health hazard data; and (11) manufacturing data and/or selected manufacturers. (Lantz-PTT)
W90-06205

WATER QUALITY OF THE LEXINGTON RESERVOIR, SANTA CLARA COUNTY, CALIFORNIA, 1978-80.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W90-06221

DISTRIBUTION AND VARIABILITY OF PRECIPITATION CHEMISTRY IN THE CONTERMINOUS UNITED STATES, JANUARY THROUGH DECEMBER 1983.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-06239

5B. Sources Of Pollution

SUPERFUND RECORD OF DECISION: LAUREL PARK, CT.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-135271. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROD/R01-88/028, June 30, 1988. 97p, 1 fig, 1 tab, 14 ref, 3 append.

Descriptors: *Superfund, *Cleanup operations, *Water pollution sources, *Connecticut, *Landfills, *Water pollution treatment, Naugatuck, Waste disposal, Volatile organic compounds, Heavy metals, Groundwater pollution, Costs.

The Laurel Park site is located in the town of Naugatuck, New Haven County, Connecticut. The landfill, occupying about 19-acres of the 35-acre site, lies entirely within the drainage basin of the Naugatuck River. It is assumed that waste disposal actions began in the late 1940s. It was common practice to burn some of the waste brought to the site. Operational problems at the landfill were imported in the early 1960s. Complaints included chemical spills on roads leading to the landfill, large quantities of black acid smoke, odors, and blowing litter. In 1961, a lawsuit was filed and, in 1964, the owner was ordered to cease burning certain waste types. Between 1965 and 1966, the Connecticut State Department of Health investigated reports of contaminated surface water. Construction of a leachate collection system was completed in 1984. The operators of Laurel Park were ordered in January 1981 to stop landfilling in an unapproved excavation area. By April 1987, the landfill ceased receiving wastes. The primary contaminants of concern affecting groundwater, soil, surface water, and sediments include: volatile organic compounds (VOCs), organics, and metals. The selected remedial action for this site includes: installation of a Resource Conservation and Recovery Act cap over all waste disposal areas; rehabilitation of the existing leachate collection system, supplemented by a shallow groundwater extraction system consisting of a French drain and/or groundwater extraction wells, with discharge and offsite treatment at the Naugatuck Water Pollution Control Facility; and monitoring of all media. The estimated present worth cost for this remedial action is $21,706,300 without pretreatment, or $23,078,200 including pretreatment, if necessary. (Author's abstract)
W90-05718

TOXIC ORGANIC COMPOUNDS IN SURFACE SEDIMENTS FROM THE ELIZABETH AND PATAPSCO RIVERS AND ESTUARIES: APPENDICES.
Virginia Inst. of Marine Science, Gloucester Point.
R. H. Bieri, C. Hein, R. J. Hugget, P. Shou, and H. Slone.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-134100. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/049b, November 1982. 194p.

Descriptors: *Water pollution sources, *Sediment contamination, *Organic compounds, *Chesapeake Bay, *Estuaries, *Elizabeth River, *Patapsco River, Pollutant identification, Aromatic compounds, Mass spectrometry, Gas chromatography, Sediment analysis, Maryland, Virginia.

An extension of the study of a Chesapeake Bay-wide analysis of toxic organic substances into the Elizabeth and Patapsco River subestuaries was conducted. Twenty-eight surface sediment samples

from the Elizabeth River and 40 surface sediment samples from the Patapsco, were analyzed in detail for the presence of mainly aromatic and polar organic compounds. Approximately 310 distinct compounds were identified by gas chromatography-mass spectrometry in the Elizabeth River samples, and about 480 in the Patapsco. Total aromatic concentrations ranged from 440,000 to 3,100 parts per billion (ppb) in the Elizabeth and from 2,700,000 to 6,100 ppb in the Patapsco. Similar to observation in the Chesapeake Bay, unsubstituted polynuclear aromatic hydrocarbons dominated, contributing about 50% to the total resolved concentration. Data lists of concentrations and computer reconstructed gas chromatograms of 'aromatic' extracts from the Elizabeth River sediments are included. (Author's abstract)
W90-05719

SORPTION OF SELECTED VOLATILE ORGANIC CONSTITUENTS OF JET FUELS AND SOLVENTS ON NATURAL SORBENTS FROM GAS AND SOLUTION PHASES.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
P. S. C. Rao, R. D. Rhue, C. T. Johnston, and R. A. Oguda.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-073. Price codes: A10 in paper copy, A01 in microfiche. Report No. ESL-TR-88-02, August 1988. Final Report. 196p, 78 fig, 23 tab, 167 ref.

Descriptors: *Path of pollutants, *Sorption, *Volatile organic compounds, *Fuel, *Solvents, *Water pollution treatment, Organic compounds, Dichloroethylene, Dichloroethane, Trichloroethylene, Tetrachloroethane, Clays, Soil contamination, Chemical analysis, Gas chromatography.

Sorption of selected volatile organic constituents (VOC) of jet fuels and solvents on several natural sorbents from the gas and aqueous phases was investigated. The sorbates studied were trans-1,2-dichloroethylene; 1,2-dichloroethane; trichloroethylene; 1,1,2,2-tetrachloroethane; toluene; ethylbenzene; p-xylene; o-xylene; and cyclohexane. The sorbents used included clays (kaolin, montmorillonite, SAz-1), soils (Webster and Oldsmar), and aquifer materials (Borden and Lula). Sorption from the vapor phase was studied using three techniques: the headspace analysis method, dynamic flow method, and a gas chromatographic method. Sorption of VOC on anhydrous sorbents and sorbents in equilibrium with water at different relative humidities was examined. The energetics of sorption were characterized by measuring VOC sorption at several temperatures. Miscible displacement techniques were used to measure effluent breakthrough curves (BTC) for trichloroethylene (TCE) and p-xylene displacement in saturated columns of Lula and Borden aquifer materials. The BTC measured at two velocities were used to evaluate the utility of a bicontinuum model for predicting sorption nonequilibrium during transport. BTC measured for displacement of binary mixtures (TCE plus p-xylene) and single solute (TCE or p-xylene) were identical, suggesting no competitive sorption. Methods were developed for molecular-level investigations of sorption on clays using Fourier Transform Infrared (FT-IR) spectroscopic techniques. These methods were used to observe IR spectra of clay minerals as dry powders, thin self-supporting films, and aqueous slurries. IR spectra were obtained for kaolinite and montmorillonite clays as well as for p-xylene adsorbed on homoionic montmorillonite, both in the presence and absence of water. The application of FT-IR methods to study the p-xylene-clay complex provided a sensitive in-situ method to observe the surface-mediated transformation of the p-xylene on the montmorillonite sample as the clay was dehydrated. Such a transformation was not noted on Na-montmorillonite. (Author's abstract)
W90-05720

SUPERFUND RECORD OF DECISION: TABERNACLE DRUM DUMP, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-05726

SUPERFUND RECORD OF DECISION: SOUTH ANDOVER, MN.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-05727

SUPERFUND RECORD OF DECISION: LONG PRAIRIE, MN.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-05728

SUPERFUND RECORD OF DECISION: DOUGLASSVILLE DISPOSAL, PA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-05729

SUPERFUND RECORD OF DECISION: NORTH CAVALCADE, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-05730

ASSESSMENT OF STREAM ACIDIFICATION IN THE CATSKILL MOUNTAINS OF NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
P. S. Murdoch, and C. R. Barnes.
IN: Regional Characterization of Water Quality. Proceedings of the Baltimore Symposium, May 1989. IAHS Publication No. 182, 1989. p 313-319, 4 fig, 3 tab, 3 ref.

Descriptors: *Path of pollutants, *Streams, *Acidification, *Catskill Mountains, *Acid rain, *New York, Sulfates, Nitrates, Alkalinity, Hydrogen ion concentration, Aluminum, Chemical analysis.

Stream and precipitation monitoring in the Catskill Mountains of New York during 1983-86 indicate acidification of some streams from atmospheric deposition. Concentrations of major ions in precipitation were similar to those reported at other northeastern sites, but precipitation volumes were greater. Average concentration of sulfate and nitrate were similar among the streams, but base-cation concentrations differed widely and paralleled the differences in stream alkalinity. Relations between sulfate and stream discharge were similar among streams at discharges ranging over 3 orders of magnitude. Differences of about 120 microequivalents/L between alkalinity values and concentrations of calcium and magnesium matched the concentrations of sulfate. Episodic decreases in alkalinity and pH during peak flows were associated with increases in nitrate concentrations during all periods except midsummer, when biological uptake of nitrogen is greatest. Concentrations of hydrogen and dissolved aluminum in streams increased when the concentrations of sulfate plus nitrate exceeded 80% of the sum of base-cation concentrations. During snowmelt in 1986, 30% of the streams had elevated aluminum concentrations (> 50 micrograms/L). (Author's abstract)
W90-05734

FLOW OF GROUND WATER THROUGH FRACTURED CARBONATE ROCKS IN THE PRAIRIE DU CHIEN-JORDAN AQUIFER, SOUTHEASTERN MINNESOTA.
Geological Survey, St. Paul, MN. Water Resources Div.
J. F. Ruhl.
Available from Books and Open Files Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 89-253, 1989. 2p, 2 fig, 6 ref.

Descriptors: *Geohydrology, *Path of pollutants, *Groundwater pollution, *Karst, *Minnesota, *Aquifers, *Groundwater movement, *Carbonate rocks, Geologic fractures, Prairie du Chien-Jordan Aquifer, Flow pattern, Riceford Creek, Seepage, Radon, Radioactive tracers.

Contamination of groundwater from point and nonpoint sources (such as landfills, feedlots, agricultural chemicals applied to fields, and septic systems) is a recognized problem in the karst area of southeastern Minnesota. The US Geological Survey, in cooperation with the Minnesota Department of Natural Resources and the Legislative Commission on Minnesota Resources, Began a study in October 1987 to improve the understanding of local groundwater flow through karst terrain in southeastern Minnesota. The objectives of the study are to: (1) describe the orientations of systematic rock fractures and solution channels of the Prairie du Chien Group of Ordovician-age carbonate rocks in southeastern Minnesota, and, if possible, to define the principal and minor axes of these orientations; and (2) evaluate the effect of fractures and solution channels in the Prairie du Chien Group on the local flow of groundwater. Groundwater in the Upper Carbonate aquifer regionally flows toward the periphery of the aquifer and locally flows into streams and bedrock valleys. The hydraulic gradient in this aquifer generally is greatest near areas of groundwater seepage to streams. Regional groundwater flow in the Prairie du Chien-Jordan aquifer generally is to the south and east in much of Fillmore and Houston Counties and in the southern parts of Olmsted and Winona Counties. Groundwater seepage to selected streams was evaluated by current-meter measurements of downstream gains or losses of streamflow and by an experimental approach based on radon activity in streams. The activity of radon in groundwater ranges from two to four orders of magnitude greater than the activity in surface water; therefore, groundwater seepage to streams generally increases the in-stream radon activity. (Lantz-PTT)
W90-05738

SUPERFUND RECORD OF DECISION: FRONTIER HARD CHROME, WA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-05741

GROUND-WATER-QUALITY ASSESSMENT OF THE CENTRAL OKLAHOMA AQUIFER, OKLAHOMA--ANALYSIS OF AVAILABLE WATER-QUALITY DATA THROUGH 1987.
D. L. Parkhurst, S. C. Christenson, and J. L. Schlottmann.
Available from Books and Open File Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 88-728, 1989. 80p, 36 fig, 21 tab, 28 ref.

Descriptors: *Groundwater quality, *Selenium, *Arsenic, *Groundwater pollution, *Oklahoma Aquifer, Sulfates, Chromium, Nitrates, Radioactivity, Heavy metals, Chlorides.

The water quality of the Central Oklahoma aquifer was assessed using the information available through 1987. The scope of the work included compiling data from Federal, State, and local agencies, evaluating the suitability of the information for conducting a regional water quality assessment, mapping regional variations in major-ion chemistry, calculating summary statistics of the available water quality data, producing maps to show the location and number of samples that exceeded water quality standards, and performing contingency-table analyses to determine the relation of geologic unit and depth to the occurrence of chemical constituents that exceed water quality standards. Contingency-table statistics indicated that the proportion of analyses that exceeded the water quality standard was significantly different among geohydrologic categories for most constituents. The following conclusions were drawn from the available data and the contingency-table statistics. The word 'common' is used to describe situations where approximately 10% or more of the data exceeded a

water quality standard: (1) groundwater concentrations of nitrate and selenium (Se) commonly exceed the 10 mg/L maximum contaminant level (MCL) in most parts of the study unit except at depths > 300 ft in the Garber Sandstone and Wellington Formation; (2) groundwater concentrations of arsenic (As) and chromium (Cr) commonly exceed the 50 micrograms/L (ug/L) MCL at depths > 300 ft in the Garber Sandstone and Wellington Formation, but rarely exceed the MCL in the rest of the study unit; (3) no data were available for residual-alpha radioactivity for many parts of the study unit. In the limited data that were available, concentrations exceeded the MCL most frequently in groundwater samples from the Chase, Council Grove, and Admire Groups; (4) groundwater pH values commonly exceed 8.5 at depths > 300 ft in the Garber Sandstone and the Wellington Formation and in the Vanoss Formation; and (5) groundwater concentrations of sulfate and chloride commonly exceed the 250 mg/L secondary MCL (SMCL) in most parts of the study unit and concentrations greater than the SMCL are most common in groundwater from the Hennessey Group. (Lantz-PTT)
W90-05749

TOXIC ORGANIC COMPOUNDS IN SURFACE SEDIMENTS FROM THE ELIZABETH AND PATAPSCO RIVERS AND ESTUARIES.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5A.
W90-05750

HANFORD SITE GROUND-WATER MONITORING DATA LISTING, JANUARY 1 THROUGH MARCH 31, 1987.
Battelle Pacific Northwest Labs., Richland, WA.
R. W. Bryce.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-016518. Price codes: A06 in paper copy, A01 in microfiche. Report No. PNL--6650, August 1988. 109p, 1 tab, 4 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Groundwater data, *Groundwater pollution, *Water pollution sources, *Path of pollutants, *Washington, *Monitoring, *Groundwater quality, *Data collections, *Uranium, Chemical analysis, Nitrates, Test wells, Hanford.

In a continuing effort for the US Department of Energy (DOE), Pacific Northwest Laboratory (PNL) is conducting groundwater monitoring at the Hanford Site, near Richland, Washington. This document contains a data listing of results for monitoring by PNL and Westinghouse Hanford Company (WHC) during January through March 1987. Samples taken during this first quarter of 1987 were analyzed and reported by the United States Testing Company, Richland, Washington. The first table in this report is a key to the constituent and constituent group names used throughout the data listing. Some constituents appear more than once in the list in different forms. Total chromium analyses were done on unfiltered and filtered samples. Each monitoring well sampled on the Hanford Site from January through March 1987 was placed into one of three groups: (1) Site-wide chemical monitoring wells; (2) compliance monitoring wells; and (3) additional Site-wide radiological and nitrate monitoring wells that were not in either of the other two networks. Therefore, all three tables should be consulted if a particular well is of interest. Most wells are sampled once during the quarter. Some exceptions include a few wells that were sampled monthly. Compliance monitoring in the 100-H and 300 Areas was conducted monthly and bimonthly, respectively. The data listing contains all chemical results (above detection levels) and radiochemical results (for which the result is larger than two times the counting error). (Lantz-PTT)
W90-05752

EFFECTS OF TEMPERATURE AND REDOX CONDITIONS ON DEGRADATION OF CHLORINATED PHENOLS IN FRESHWATER SEDIMENTS.
Environmental Research Lab., Athens, GA.
J. E. Rogers, G.-W. Kohring, and J. Wiegel.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-129118. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/048, November 1988. 17p, 6 fig, 1 tab, 21 ref.

Descriptors: *Fate of pollutants, *Chlorinated phenols, *Biodegradation, *Sediment contamination, *Water temperature, *Degradation, Freshwater, Oxidation-reduction potential, Ponds, Dichlorophenol, Methane, Anaerobic bacteria, Dechlorination.

The effect of temperature and redox conditions on the anaerobic degradation of 2,4-dichlorophenol (2,4-DCP) was investigated in anaerobic sediment slurries, prepared from local freshwater pond sediments. Under methanogenic conditions, 2,4-DCP dechlorination occurred in the temperature range between 5 C and 50 C. Although dechlorination was not observed above 50 C, anaerobic bacterial activity was indicated by methane formation up to 60 C. In sediment samples from two sites and at all temperatures from 5 to 50 C, 2,4-DCP was transformed to 4-chlorophenol (4-CP). The 4-CP intermediate was subsequently degraded after an extended lag period. Adaptation periods for 2,4-DCP transformation decreased between 5 and 25 C, were essentially constant between 25 and 35 C, and increased between 35 and 40 C. Degradation rates increased exponentially between 15 and 30 C, had a second peak at 35 C, and decreased to about 5% of the peak activity by 40 C. In one sediment sample, an increase in degradation rates was observed following the minimum at 40 C, suggesting that at least two different organisms were involved in the 2,4-DCP dechlorination. Storage of the original sediment slurries for 2 months at 12 C resulted in increased adaptation times but did not affect the degradation rates. (Author's abstract)
W90-05756

TRACE ELEMENT CONCENTRATIONS IN TRANSPLANTED AND NATURALLY OCCURRING UNIONIDAE MUSSELS, WATER, SEDIMENTS, AND MACROPHYTES IN CAYUGA LAKE.
Department of Energy, New York. Environmental Measurements Lab.
S. Silvestri, M. Heit, and C. S. Klusek.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-016988. Price codes: A04 in paper copy, A01 in microfiche. Report No. EML--514, August 1988. 76p, 2 fig, 33 tab, 21 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *New York, *Bioaccumulation, *Biological magnification, *Trace elements, *Mussels, *Cayuga Lake, Aluminum, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Sediment contamination, Copper, Iron, Mercury, Manganese, Molybdenum, Nickel, Lead, Selenium, Strontium, Titanium, Vanadium, Zinc, Aquatic plants.

A compilation of element data which is used to determine the environmental fate of combustion-produced pollutants released from a coal-fired electric generating station into an aquatic ecosystem is presented. An important part of this research is to determine which compartments within the ecosystem are sequestering and/or biomagnifying particulate-associated pollutants such as heavy metals, radionuclides, and organic compounds. The trace elements selected for study in the aquatic ecosystem were: Ag, Al, As, Be, Cd, Co, Cr, Cu, Fe, Ga, Hg, Mn, Mo, Ni, Pb, Se, Sc, Sn, Sr, Ti, V, and Zn. Cayuga Lake, in the Finger Lakes region of New York State, was the study location for this program. A coal-fired power plant is located on its eastern shore. The organisms selected for this study were freshwater bivalves belonging to the family Unionidae and macrophytes. In addition to the mussels which naturally occur in Cayuga Lake, three species of freshwater mussels were collected from Lake George, NY and transplanted to sites in Cayuga Lake at various distances from the Milliken Station coal-fired power plant. Samples of water, sediment, fish, macrocrustaceans, and plankton were also collected along with the mussels and macrophytes. Correlation coefficients were calculated for a comparison of the trace element and biota sampled. (Lantz-PTT)
W90-05763

MOBILITY OF SOIL CONTAMINANTS IN AN ECOSYSTEM OF TREES GROWING ON DREDGED MATERIAL--THE BROEKPOLDER (ROTTERDAM, THE NETHERLANDS).
European Research Office, London (England).
S. H. Kay, M. C. T. Scholten, and C. T. Bowmer.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-919. Price codes: A04 in paper copy, A01 in microfiche. Report No. R 88/488, December 1988. 73p, 1 fig, 20 tab, 98 ref. DOA Report DAJA45-87-C-0054.

Descriptors: *Path of pollutants, *Bioassay, *Sediment contamination, *Bioaccumulation, *Cadmium, *Copper, *Zinc, Chlorinated hydrocarbons, *Polychlorinated biphenyls, Organic matter, Plants, DDE, Oligochaetes, Sludge disposal.

A study was conducted to determine whether or not plant (Cyperus esculentus) and earthworm (Eisenia foetida) bioassays applied to sediments adequately predict the long-term environmental impacts of disposed contaminated dredged material in upland sites. At the end of 45-day and 28-day exposure periods, respectively, plants and earthworms were analyzed for Cd, Cu and Zn. Additionally, earthworms were analyzed for several organochlorine contaminants including HCB, DDE, and PCBs. Humic and anaerobic soil layers from the poplar, oak, and maple stands, WES reference soil, and a surface soil samples from a nearby 'reference' poplar forest elsewhere on the Broekpolder were analyzed for both the metals and organochlorine contaminants. Soil pH ranged from slightly acidic to slightly basic. Soil organic matter content was highest in humid soils (36-67%) and lowest in anaerobic soils (14.5-21%). No relationship was found between soil pH and organic matter. Humic soils generally contained higher concentrations of total and bioavailable metals than anaerobic layer soils. Concentrations of An and Cd were significantly greater in humic soils from the poplars than elsewhere. Metal concentrations in newly-fallen leaves were lower than in leaf litter from the previous season. Concentrations of Cd and Zn were greatly elevated in litter and leaffall in the poplar stand, compared with either the oaks or maples. Concentrations of Cu in leaves and leaffall were generally similar across the experimental forest. Earthworm recovery (numbers) was excellent in all cases, but weight loss due to decreased body weight was significantly on all anaerobic layer soils and most humic soils. Bioaccumulation of Cd by earthworms was significant greater on humic than anaerobic layer soils, especially Cd in worms on poplar soils; copper and zinc uptake were not significantly different. Bioaccumulation of HCB and DDE by earthworms was greater on humic than anaerobic layer soils; other organic compounds (PP, DDE and PCBs) were bioaccumulated more from anaerobic layer soils. (Lantz-PTT)
W90-05765

CYCLIC METAL MIGRATION IN A GROUND-WATER STREAM.
Paul Scherrer Inst., Wuerenlingen (Switzerland).
H. R. Von Gunten, L. Jacobs, M. Kuslys, R. Kell, and U. Krahenbuhl.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-703470. Price codes: A02 in paper copy, A01 in microfiche. PSI-Bericht No. 4, April 1989. 7p, 5 fig, 11 ref. From: IAHR International Symposium on the Interaction Between Groundwater and Surface Water, Ystad, Sweden, 1988.

Descriptors: *Path of pollutants, *Metals, *Groundwater pollution, *Infiltration, Groundwater movement, Hydrogen ion concentration, Seasonal variation, Copper, Zinc, Cadmium, Organic matter, Manganese.

The behavior of dissolved (< 0.45 micrometers (um)) inorganic species (e.g. metals, anions), and changes in relevant properties of polluted river

water during infiltration into adjacent groundwater area is investigated. Water from the river and from several wells is analyzed for temporal and spacial changes. For many of the measured quantities a pronounced annual cycle is observed. The temperature differences between summer and winter influence biological activity. Growth and degradation of organic material lead to drastic changes in pH and redox conditions in the near infiltration field. During summer, under relatively anoxic conditions, manganese oxides/hydroxides dissolve. In winter, the higher concentration of dissolved oxygen induce reprecipitation of manganese. Trace metal mobility (e.g. Cu, Zn, Cd) is influenced by these annual variations. In the river, daily cycles are observed for many of the measured quantities. These short-term variations are induced by photosynthesis and respiration of aquatic biota. The cyclic behavior disappears during the early stage of infiltration. The changes between river and groundwater can be modelled by a combination of simplified electron transfer and weathering reactions. (Author's abstract)
W90-05767

IDENTIFICATION OF POLLUTANTS SUBJECT TO NONPOINT AGRICULTURAL MEASURES IN THE MAUMEE RIVER BASIN.
Purdue Univ., Lafayette, IN.
J. B. Morrison.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 101-120, 4 tab, 9 ref.

Descriptors: *Agricultural runoff, *Maumee River Basin, *Nonpoint pollution sources, *Ohio, *Soil erosion, *Water pollution control, *Water pollution sources, Black Creek, Erosion control, Lake Erie, Water resources management.

Efficient planning for resource management requires several clearly defined steps: (1) identification of the impaired use of a resource; (2) identification of those pollutants that are responsible for the degradation of the resources; (3) development of a strategy to control those pollutants; and, (4) careful implementation of the strategy while observing and attempting to understand and account for environmental side effects. Unfortunately, this type of analysis is not often routinely applied to planning for control of pollution from nonpoint sources which are often diffuse. By its very nature, the conduct of agricultural activities results in a disturbance of the natural environment. In addition, agricultural point sources occur at large confined animal feeding or breeding installations, at areas where agricultural materials are stored in large quantities, at processing facilities, and at the sites of accidental spills of agricultural chemicals or animal waste. In the Maumee River Basin, rainstorms occurring when cropland was not protected by vegetation were an important cause of erosion, and the Maumee River was the largest contributor to sediment entering Lake Erie. More serious than the sediment entering the lake were the nutrients associated with the sediments. A management plan has been implemented that includes conservation tillage, no-till farming, herbicide control, and terracing. By identifying the specific pollutant source and concentrating efforts on eliminating the origin of the source, erosion, specific remedial measures could be designed. (See also W90-05772) (Lantz-PTT)
W90-05776

HISTORICAL SYNOPSIS OF GREAT LAKES WATER QUALITY RESEARCH AND MANAGEMENT AND FUTURE DIRECTIONS.
Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station.
W. L. Richardson, and J. F. Paul.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 150-175, 12 fig, 4 tab, 14 ref.

Descriptors: *Great Lakes, *Path of pollutants, *Water pollution control, *Water quality, *Water quality management, Eutrophication, Fate of pollutants, Green Bay, History, Model studies.

When US-USSR discussions first began in 1972, the US EPA was just becoming involved with major efforts to protect and clean the North American Great Lakes. Severe water quality issues were confronting the United States and Canada--most notably, eutrophication and the consequential impacts on drinking water, fisheries, and recreation. The International Field Year on the Great Lakes (IFYGL) had begun, planning for the Upper Great Lakes Reference Studies (UGLRS) was starting, and work had begun through the International Joint Commission in designing a long-term surveillance plan for the Great Lakes. In the following 16 years, much has been accomplished in understanding cause-effect relationships and in managing water quality in the Great Lakes. Most notable was the establishment of target loadings for phosphorus, which were established largely by the negotiations among governmental representatives facilitated by the quantitative relationships derived through modeling research. With phosphorus target loadings established, control programs in place, and eutrophication declining, effects of toxic substances became the major environmental issue for the Great Lakes in the 1980s. Initial monitoring and research into cause-effect relationships has indicated that rational management of toxics is and will continue to be, a difficult problem. The progress made in managing eutrophication is reviewed and some research results in the Great Lakes are summarized along with a discussion of the approach being taken in planning a major field and modeling (mass balance) study of Green Bay (Lake Michigan). (See also W90-05772) (Lantz-PTT)
W90-05778

PROCEDURAL-METHODOLOGICAL PROBLEMS OF INVESTIGATING PETROLEUM PRODUCTS IN CONTINENTAL SURFACE WATERS.
Hydrochemical Inst., Rostov-na-Donu (USSR).
A. G. Stradomskaya.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 177-190, 1 fig, 2 tab, 23 ref.

Descriptors: *Fate of pollutants, *Monitoring, *Oil pollution, *Path of pollutants, *Surface water, *Water pollution sources, Chemical analysis, Water pollution control.

The extreme complexity and diversity of petroleum product compositions is the reason for the difficulties that occur in evaluating contamination of bodies of water by these compounds. The diverse and numerous contamination sources of continental surface waters include: oil production and refining operations, and storage facilities, as well as water and land transport equipment. Surface waters have an extremely complex, diverse and dynamic chemical composition, determined by a great variety of formation and transformation factors. These include primarily lipids of natural origins, particularly their hydrocarbon fractions, consisting of normal, branched paraffins, isoparaffins and isoprenoids, which are also present in petroleum production. A number of the characteristic features of interior basins influencing the behavior of petroleum products may change within broad limits. Among these features are intensive mixing, often complete mixing of the water masses, heating of the water layer, and the significant influence of the benthic deposits and suspended substances. The methodology of investigating petroleum product contamination of surface water is made much more difficult when the petroleum products contain a wide range of organic substances entering with the sewage of various production processes and household waste. Methods designed for use in monitoring must be simultaneously: sensitive, precise and productive; modern; specific; and adequately simple and accessible. It was determined that it is necessary to consider the volatile and nonvolatile hydrocarbons, the tars, and the asphaltenes for obtaining the correct information on the total content of petroleum products. Methods used for determining these contaminants include: pyrolytic burning, simultaneous infrared and ultraviolet photometry, irradiation, and variants of gas liquid chromatography-chromatomass spectrometry and highly efficient liquid chromatography. (See also W90-05772) (Lantz-PTT)
W90-05779

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 6 -- APPENDIX B (CONTD).
Battelle Pacific Northwest Labs., Richland, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-017215. Price codes: N01 in paper copy. Report No. PNL--6581-Vol.6, May 1988. 605 p. DOE Contract DE-AC06-76RLO-1830.

Descriptors: *Data collections, *Groundwater management, *Groundwater quality, *Hanford Site, *Monitoring, *Radioactive wastes, *Washington, *Wells, Inspection, Well construction, Well logs.

This appendix is one of nine volumes, and presents data describing wells completed at the Hanford Site during the fourth quarter of the calendar year 1987 (October through December). The data in this volume of Appendix B cover the following wells: 299-W7-5, 299-W7-6, 299-W8-1, 299-W9-1, and 299-W10-13. The data are presented in the following order: well completion report/Title III inspection list, inspection plan, as-built diagram, logging charts, and drill logs. (See also W90-05786) (Lantz-PTT)
W90-05785

PCB CONCENTRATIONS IN WILSON RESERVOIR CATFISH - 1986.
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
D. L. Dycus, and D. R. Lowery.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-016103. Price codes: A03 in paper copy, A01 in microfiche. Report No. TVA/ONRED/AWR--88/2, August 1987. 44p, 4 fig, 9 tab, 3 ref, 4 append.

Descriptors: *Alabama, *Bioaccumulation, *Catfish, *Fish, *Path of pollutants, *Polychlorinated biphenyls, *Tennessee, *Wilson Reservoir, Public health, Seasonal variation.

For three years the Tennessee Valley Authority (TVA) has been involved in a study on Wilson Reservoir to evaluate the year-to-year trend in polychlorinated biphenyl (PCB) concentrations in catfish. Samples taken the first year of study (1984) revealed 22 of 45 catfish equaled or exceeded the Food and Drug Administration (FDA) tolerance of 2.0 micrograms/g, and the overall average was 2.6 microg/g. Catfish collected in 1985 showed substantially reduced PCB levels with only 4 of 36 individuals at or above 2.0 microg/g and the overall average at 1.0 microg/g. Such a large reduction was unexpected because there had been no known major corrective actions taken between 1984 and 1985 which would have been expected to reduce levels throughout the reservoir. The possibility that extreme hydrologic conditions may have been important in causing the difference between the two years was presented as one hypothesis. Fish in autumn 1984 were collected five months after a 100-yr flood event in the Tennessee River, whereas fish in autumn 1985 were collected following a drought which began soon after the 1984 flood. Because PCBs are typically associated with sediments, any action which stirs up existing sediments (even contaminated at very low levels) or washes in new contamination from terrestrial sources could be expected to influence PCB levels in fish. Another possibility was that an unknown polluter suspended illegal dumping once the 1984 data were made public. Catfish collected in 1986 supported findings of the 1985 study by showing even further reductions in PCB levels. Of the 36 catfish analyzed, none exceeded 2.0 microg/g (the highest was 1.9 microg/g), the overall average was 0.46

microg/g, and not even the 99.9% confidence interval for any location included 2.0 microg/g. Therefore, it appears there should be little concern from consumption of catfish from Wilson Reservoir. (Lantz-PTT)
W90-05788

AIR POLLUTION AND ACIDIFICATION.
National Swedish Environment Protection Board, Solna.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-754411. Price codes: A03 in paper copy, A01 in microfiche. Report No. NEI-SE--18, (1988). 10p, 18 ref.

Descriptors: *Acid rain, *Air pollution, *Path of pollutants, *Sweden, *Water pollution effects, *Water pollution sources, Corrosion, Forest watersheds, Groundwater pollution.

In Sweden the environmental problems that are traceable to air pollution are being attacked on a wide front. The main problems are grouped into the following five areas, with research being carried on in each: deposition, forests and soils, groundwater and corrosion, surface water, and wildlife. At present the highest priority is being given to studies of forest damage and the effects of acidification on groundwater, although the corrosion of buried structural materials is also tending to receive special attention. An account is given of the research and monitoring activities that are currently being carried on in Sweden in regard to air pollution and acidification, as well as the countermeasures that are being taken within the country itself to check both. The account reflects the findings of a large number of research projects; the countermeasures arising from them are outlined, and there is a list of the various agencies and institutions involved in the work. (Lantz-PTT)
W90-05789

ACID RAIN--MODELLING ITS RISKS TO THE EUROPEAN ENVIRONMENT.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W90-05793

RIVER DANUBE POLLUTION AND ITS RISK ASSESSMENT.
Benezur U. 28, H-1068, Budapest, Hungary.
P. Benedek.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 315-362, 8 fig, 10 tab, 65 ref.

Descriptors: *Danube River, *Path of pollutants, *Risk assessment, *Urbanization, *Water pollution sources, Ammonia, Fertilizers, Industrial wastes, Inorganic compounds, Nonpoint pollution sources, Oil pollution, Organic compounds, Pesticides, Sediment transport, Wastewater pollution, Water quality.

The catchment area of the Danube and the geographic borders of the riparian countries, include: Austria, Czechoslovakia, Hungary, Romania, Yugoslavia, and West Germany. As a major water resource and traditional communication route it has yielded excellent opportunities for urban, agricultural, and industrial development from Roman times to the present day. During the past decades, tremendous development in the catchment area, urbanization, industrialization, hydropower exploitation, and intensified agriculture, led to changes in the morphology, hydrology, and biogeochemical, and ecological characteristics of the river. This includes increasing flood potential, decreasing icy periods, and decreasing bed load and sediment transport, all leading to a deteriorating trend in water quality. However, the quality of the river is still fairly good with the exception of relatively short stretches downstream from major wastewater discharges and polluted tributary confluences. Apart from incidental and accidental risks (municipal sewage release, oil and oil derivatives, organic industrial wastes, inorganic industrial wastes, manure (liquid), pesticides, fertilizers, putrescible organic waste of unknown origin, ammonium ion, and others of unknown origin), intentional risks appear as significant factors in water management. Though management can control the major effects of wastewater discharges, it has to tolerate some residual pollutants in the water due to technical and mainly economic considerations. The same is true for the runoff water from agricultural areas. Specific changes in the ecosystem are expected as a result of exploiting the hydropower potential of the river. (See also W90-05792) (Lantz-PTT)
W90-05794

TOTAL INDEX OF ENVIRONMENTAL QUALITY AS APPLIED TO WATER RESOURCES.
Ceske Vysoke Uceni Technicke v Praze. Fakulta Jaderna a Fysikalne Inzenyrska.
For primary bibliographic entry see Field 6B.
W90-05795

DYESTUFFS AND THE ENVIRONMENT--A RISK ASSESSMENT.
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
D. Brown, and R. Anliker.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 398-413, 1 fig, 1 tab, 42 ref.

Descriptors: *Dyes, *Fate of pollutants, *Path of pollutants, *Risk assessment, *Toxicity, *Toxicology, Aquatic environment, Biodegradation, Biological wastewater treatment, Industrial wastewater, Sorption.

The vast number of dyestuffs, and the many varied situations in which they are used and applied, inevitably means that an environmental risk assessment can only properly be made on an individual dyestuff and an individual dye-house basis. However, for most dyestuffs aquatic toxicity data will be available to demonstrate that provided any dyestuff discharge results in levels below those visible in a natural water, then no significant risk to water organisms in that water is likely. For those dyestuffs where this statement may not apply, it is particularly important to consider levels of discharge both in factory effluents and following biological treatment. The basic dyestuffs which are most likely to be toxic are in general very substantive to the substrate which they are dyeing and are also well removed in biological treatment processes. The likely environmental fate of dyestuffs is by sorption either on to sewage works sludges or on to the sediments of natural waters where azo dyestuffs in particular will be degraded in an anaerobic environment. The available data indicate that the amines produced as the anaerobic metabolic products will themselves be degradable or be essentially nontoxic to aquatic life. (See also W90-05792) (Lantz-PTT)
W90-05797

HAZARD AND RISK ASSESSMENT AND ACCEPTABILITY OF CHEMICALS IN THE ENVIRONMENT.
Technical Univ. of Denmark, Lyngby. Lab. of Environmental Science and Ecology.
For primary bibliographic entry see Field 5C.
W90-05799

STUDIES ON THE FATE OF CHEMICALS IN THE ENVIRONMENT WITH PARTICULAR REFERENCE TO PESTICIDES.
Schering Agrochemicals Ltd., Essex (England).
L. Somerville.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 451-480, 8 fig, 4 tab, 24 ref.

Descriptors: *Fate of pollutants, *Pesticides, *Risk assessment, *Toxicity, *Water pollution sources, Agricultural runoff, Aquatic environment, Bioaccumulation, Biodegradation, DDT, Fish, Lethal limit, Nonpoint pollution sources, Polychlorinated biphenyls, Soil contamination.

Large quantities of pesticides are used each year. For good biological efficacy, adequate coverage of the crop is essential. Despite extensive efforts on the part of the industry to develop precision methods of application including controlled droplet spraying and electrostatic techniques, only part of the pesticide application reaches the target pest, the remainder being distributed in the non-target sectors of the agricultural ecosystem, i.e., the foliage, the soil, adjacent streams and hedgerows. While the soil may appear to be the ultimate site for the pesticide, consideration must also be given to the aquatic system, and to terrestrial wildlife. Soil harbors vast numbers of bacteria, actinomycetes, fungi, and algae. These microorganisms are of prime importance not only in degrading pesticides in soil and water system, but also for breaking down plant debris into nutrients which are then available for new plant growth. Disturbance of these key biological processes may have an effect on soil fertility. Contamination of natural waters with a pesticide may occur as a consequence of spray drift, soil erosion, or runoff into streams. Standardized laboratory test methods have been devised to give information on such aspects. The simplest test for toxicity is to expose the test organism to the chemical substance for a specified time. The results are expressed as an LD50, LC50, or EC50 value. The values are a measure of the extent to which a chemical affects a test organism. Equally important is the need to test for possible bioconcentration of the chemical in fish when they are continuously exposed to sublethal concentrations. In such situations it is not only important to know whether the chemical would accumulate in the edible tissues, but also whether the influx of fresh water would rapidly cleanse the tissues. Examples of pesticide toxicity and fate are presented using polychlorinated biphenyls and DDT. Model studies show that solar photolysis can reduce the levels of PCBs in large lakes and oceans, but any accumulation in sediments, would be unaffected by sunlight. Fourteen years after the input of DDT was stopped, residue levels in the aquatic ecosystems are still extremely high. (See also W90-05792) (Lantz-PTT)
W90-05800

PESTICIDES IN THE AQUATIC ENVIRONMENT--DATA NEEDS FOR THEIR CONTROL.
Department of the Environment, London (England). Water Quality Div.
R. J. Otter.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 481-490, 1 tab, 5 ref.

Descriptors: *Pesticides, *Risk assessment, *Water pollution control, *Water pollution sources, Chemical wastes, Fate of pollutants, Pollutant identification, Priority pollutants.

The presence of pesticides is being measured and increasingly confirmed in ground and surface waters. They are the most likely substances to cause serious problems in the aquatic environment. Risk assessment depends on the quality of the data used to make the assessment but pesticides databases have a number of serious deficiencies, as follows: (1) quantities and patterns of use; (2) chronic toxicities for a range of organisms; (3) environmental concentrations; (4) persistence data; and (5) laboratory quality control. The results of an exploratory survey of rivers in England indicate that some herbicides are widely distributed in these rivers. Risk assessment must be based on the best available data; if this data is inadequate, the judgements about risk must be conservative. (Lantz-PTT)
W90-05801

CHESAPEAKE BAY EARTH SCIENCE STUDY: INTERSTITIAL WATER CHEMISTRY--CHEMICAL ZONATION, TRIBUTARIES STUDY AND TRACE METALS.
Maryland Geological Survey, Baltimore.
For primary bibliographic entry see Field 2L.
W90-05808

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM. STATISTICAL AND ANALYT-

ICAL SUPPORT CONTRACT: FINAL REPORT. VOLUME II.
Martin Marietta Environmental Systems, Columbia, MD.
For primary bibliographic entry see Field 5A.
W90-05811

METABOLISM OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE AQUATIC ENVIRONMENT.
CRC Press, Inc. Boca Raton, Florida. 341 p. Edited by Usha Varanasi.

Descriptors: *Bioaccumulation, *Biodegradation, *Fate of pollutants, *Hydrocarbons, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Toxicity, Oil spills, Water pollution, Water pollution effects.

During the past decade, knowledge about polycyclic aromatic hydrocarbons (PAH) in the aquatic environment has advanced substantially to encompass studies of bioavailability, metabolism, subsequent toxic effects, and their ecological consequences. The impetus for these studies has come from diverse developments, including increased transport of petroleum across major waterways of the world and consequent concern about accidental spills, reports of epizootics of diseases in fish populations from PAH-contaminated areas, and a general awareness of the problems of marine pollution, including implications toward human health. Recent advances in the areas of PAH biogeochemistry and bioaccumulation, microbial degradation, enzymes of activation and detoxication, metabolism of PAH, and laboratory and field studies on carcinogenic/toxic effects, are presented. Additionally, important similarities and differences in metabolism of PAH by aquatic and terrestrial organisms are discussed. Although considerable progress has been made in certain areas of PAH metabolism in the aquatic environment, the field is relatively unexplored and many exciting possibilities exist for future investigations. Because many aquatic organisms reside in confined waters, where they may be exposed to xenobiotics over long periods of time, they serve as good models for studies to establish cause and effect relationships between exposure to xenobiotics and subsequent biological effects. Further, the ability to integrate information from controlled laboratory studies with epizootological data on the same species gives added strength to their use in such studies. Therefore, the epizootological evidence for the role of PAH as etiologic agents in piscine hepatocarcinogenesis is evaluated. The use of fish models in experimental carcinogenesis is also considered, even though much of this information is not obtained using PAH. Except for this specific emphasis, the underlying theme of the book is to show how biological transport, bioaccumulation, disposition, and toxicity of PAH in the aquatic environment are influenced by the ability or inability of organisms to metabolize these environmental pollutants. (See W90-05813 thru W90-05822) (Lantz-PTT)
W90-05812

BIOAVAILABILITY OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE AQUATIC ENVIRONMENT.
Massachusetts Univ. at Boston. Environmental Science Program.
A. E. McElroy, J. W. Farrington, and J. M. Teal.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 1-39, 14 fig, 9 tab, 159 ref. NOAA Contract 83-ABD-00012.

Descriptors: *Bioavailability, *Fate of pollutants, *Metabolism, *Path of pollutants, *Polycyclic aromatic hydrocarbons, Anthracene, Aquatic environment, Benzenes, Bioaccumulation, Environmental effects, Field studies, Laboratory methods, Naphthalenes, Phenanthrene, Water pollution sources.

Information on the bioavailability of polynuclear aromatic hydrocarbons or polycyclic aromatic hydrocarbons (PAH) (such as benzene, naphthalene, phenanthrene, and anthracene) and their metabolites in the aquatic environment is reviewed. Emphasis is placed on the physical/chemical, biological, and environmental factors which drive these processes. A rationale is provided for why it is important to study metabolism when considering the fate of PAH in aquatic systems. The chapter is divided into three main sections. The first introduces PAH, their sources, transformations, and sinks, and the physical/chemical factors which influence their cycling in the environment. The second section reviews information gathered from field studies on the bioavailability of PAH to aquatic organisms. Information derived from laboratory investigations on processes influencing bioavailability is discussed in the third section. Due to the complexity of the many parameters which influence the fate of compounds such as PAH in the environment, studies of these processes in the field are required to obtain a realistic assessment of the environmental fate of PAH. For the same reasons it is very difficult and often impossible to do controlled experiments in the field. The chapter focuses first on field-collected data on PAH bioavailability, and then supplements this discussion with information derived from laboratory studies. (See also W90-05812) (Lantz-PTT)
W90-05813

MICROBIAL DEGRADATION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN THE AQUATIC ENVIRONMENT.
National Center for Toxicological Research, Jefferson, AR.
C. E. Cerniglia, and M. A. Heitkamp.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 41-68, 11 fig, 3 tab, 114 ref.

Descriptors: *Biodegradation, *Fate of pollutants, *Microbial degradation, *Polycyclic aromatic hydrocarbons, Algae, Aquatic environment, Bacteria, Benzanthracene, Benzenes, Benzopyrene, Fungi, Naphthalenes, Sediment-water interfaces, Water pollution.

Microorganisms play an important role in recycling of elements such as carbon, nitrogen, phosphorus, oxygen, and sulfur, and in the degradation of organic compounds to carbon dioxide and water in nature. In recent years, the concern about the presence of polycyclic aromatic hydrocarbons (PAH) in air, soil, and water systems has increased, since this important class of chemicals is carcinogenic in experimental animals and a potential health risk to man. A summary of the structure, toxicity, and genotoxicity of PAH commonly found in soils and aquatic ecosystems is given. PAH are mainly formed as products from the combustion of fossil fuels and also occur as natural constituents of unaltered fossil fuels. Due to their hydrophobic properties and limited water solubility, PAH tend to adsorb to particulates and eventually migrate to the sediments in river, lake, estuarine, and marine waters. The PAH levels ranged from 5 parts per billion (ppb) for an undeveloped area in Alaska to 1,790,000 ppb for an oil refinery outfall in Southampton, England. Sediments from other industrialized areas ranged from 198 to 232,000 ppb. A variety of processes including volatilization, adsorption, chemical oxidation, photodecomposition, and biodegradation are important mechanisms for environmental loss of PAH. In reviewing the literature, some general statements can be made about the present knowledge of the microbial degradation of PAH: (1) a wide variety of bacteria, fungi, and algae have the ability to metabolize PAH; (2) hydroxylation of unsubstituted PAH always involves the incorporation of molecular oxygen; (3) PAH with more than three condensed benzene rings do not serve as substrates for microbial growth; (4) fungi hydroxylate PAH as a prelude to detoxification, whereas bacteria oxidize PAH as a prelude to ring fission and assimilation; (5) lower weight PAH such as naphthalene degrade rapidly, while higher weight PAH such as benz(a)anthracene or benzo(a)pyrene are quite resistant to microbial attack; (6) most rapid biodegradation of PAH occurs at the water/sediment interface and degradation rates can be influenced by environmental factors; and (7) microbial adaptations can occur from chronic exposure to PAH. (See also W90-05812) (Lantz-PTT)
W90-05814

BIOTRANSFORMATION AND DISPOSITION OF PAH IN AQUATIC INVERTEBRATES.
Florida Univ., Gainesville. J. Hillis Miller Health Center.
M. O. James.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 69-91, 9 fig, 2 tab, 81 ref.

Descriptors: *Biodegradation, *Biotransformation, *Fate of pollutants, *Invertebrates, *Metabolism, *Polycyclic aromatic hydrocarbons, Annelids, Aquatic environment, Arthropods, Biological studies, Echinoderms, Mollusks, Protozoa.

A combination of in vivo and in vitro studies has shown that cytochrome P-450-dependent monooxygenation, the first step in PAH biotransformation, is usually slower in invertebrates than vertebrates, sometimes proceeding at rates so slow as to be undetectable by many standard techniques; and, furthermore, that PAH metabolites are excreted quite inefficiently by invertebrates. Monooxygenation of PAH occurred most rapidly in higher invertebrates, such as arthropods, echinoderms, and annelids and very slowly or not at all in the more primitive invertebrates, such as protozoa, porifera, cnidaria, and mollusks. Where metabolism occurred, wide interspecies variations were observed in rates of biotransformation. More information is needed on PAH biotransformation and the regulation of cytochrome P-450 in invertebrate species before clear conclusions can be drawn concerning the ability of a particular species to biotransform PAH. A few studies have examined the influence of environmental temperature on PAH biotransformation, in vivo and in vitro, and on PAH metabolite excretion. While it is clear that PAH biotransformation proceeds in vitro more rapidly at higher temperatures, there are insufficient studies to conclude that this is true in vivo. There is evidence that PAH metabolite excretion by the spiny lobster is more rapid at higher environmental seawater temperatures. Further studies are needed to clearly delineate the effects of temperature on PAH biotransformation and excretion of PAH metabolites. (See also W90-05812) (Lantz-PTT)
W90-05815

BIOTRANSFORMATION AND DISPOSITION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN FISH.
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
U. Varanasi, J. E. Stein, and M. Nishimoto.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 93-149, 20 fig, 15 tab, 171 ref.

Descriptors: *Bioaccumulation, *Biotransformation, *Fate of pollutants, *Fish, *Metabolism, *Polycyclic aromatic hydrocarbons, Benzanthracene, Benzenes, Benzopyrene, Naphthalenes, Sediment contamination, Tissue analysis, Toxicity.

During the early to mid-1970s, concern about the impact of oil spills on the aquatic environment had heightened, and, consequently, there was great interest in evaluating the uptake and disposition of petroleum constituents, especially benzenes and polycyclic aromatic hydrocarbons (PAH) in fish and shellfish. Measurements of tissue concentrations of benzenes and PAH in fish sampled from oil-impacted areas or urban estuaries showed the presence of aromatic hydrocarbons with 1-3 benzenoid rings, such as derivatives of benzene, naphthalene (NPH), biphenyl, and phenanthrene (PHN), but rarely showed detectable levels of 4-ring and 6-ring PAH, such as benz(a)anthracene (BaA) or benzo(a)pyrene (BaP). In the late 1970s and early 1980s, however, considerable evidence was obtained that demonstrated strong, positive associations between levels of PAH in sediments and prevalence of hepatic neoplasms in benthic fishes from polluted areas in the US. These findings, along with the detection of PAH, such as BaP and

BaA, in microgram-per-gram levels in urban sediments, and the results with rodents demonstrating that these PAH exert their carcinogenic and teratogenic effects only after metabolic activation, have given a strong impetus to studies of bioavailability and metabolism of carcinogenic PAH by fish. The current interest in biotransformation and disposition of PAH in fish stems from two rather divergent perspectives: one is to evaluate the potential of food chain transfer of toxic PAH and their metabolites, and the other is to evaluate mechanisms of toxicity of environmental pollutants in fish. Endogenous and exogenous factors that affect metabolism and disposition of PAH in fish, are discussed, followed by a discussion of the metabolic activation and detoxication of PAH, with emphasis on the disposition of phase I and phase II metabolites in various tissues and fluids, and the interactions of reactive intermediates with cellular macromolecules. (See also W90-05812) (Lantz-PTT)
W90-05816

ENZYMES INVOLVED IN METABOLISM OF PAH BY FISHES AND OTHER AQUATIC ANIMALS: OXIDATIVE ENZYMES (OR PHASE I ENZYMES).
Oregon State Univ., Corvallis. Toxicology Program.
D. R. Buhler, and D. E. Williams.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 151-184, 5 tab, 228 ref. National Institute of Environmental Health Science Grant Nos. ES0040, ES00210, and ES03850.

Descriptors: *Biochemistry, *Enzymes, *Fate of pollutants, *Fish, *Metabolism, *Polycyclic aromatic hydrocarbons, Aquatic animals, Benzopyrene, Biological studies, Biotransformation, Chemical analysis, Cytochromes.

Freshwater and coastal marine environments act as sinks for the deposition of numerous chemicals (xenobiotics) of natural and anthropogenic origin. Xenobiotics such as the polycyclic aromatic hydrocarbons (PAH) and the polychlorinated biphenyls (PCB) resist chemical and biological degradation and tend to persist in the aquatic environment. Biotransformation reactions are usually classified into two categories, phase I and phase II reactions. Phase I reactions introduce polar groups into the xenobiotic molecule through oxidative, hydrolytic, or reductive processes. Phase II reactions involve conjugation of xenobiotics or their phase I metabolites with polar cellular constituents such as glucuronic acid, sulfate, or glutathione to form highly water soluble conjugates, easily excreted via bile, kidney, or gill. Although not as thoroughly studied as in mammals, the comparative metabolism of xenobiotics by fish and other aquatic animals has been the subject of several previous reviews. The enzymes involved in the oxidative metabolism of PAH by fishes, crustaceans, mollusks, and other aquatic animals are discussed. Special emphasis is given to the cytochrome P-450-dependent mixed-function oxidase (MFO) system. These lipophilic compounds are oxygenated by cytochrome(s) P-450 to produce either detoxication metabolites, usually in conjunction with the phase II conjugation enzymes, or to activated electrophilic metabolites which can covalently react with macromolecules producing a variety of toxic effects, including carcinogenesis. The metabolic activation of PAH, such as BaP, has been extensively studied in mammals. Acquisition of the purified P-450 isozymes involved and a combined utilization of metabolism and molecular biology studies have resulted in a more complete understanding of the properties, function, and regulation of this pathway. A good deal of effort by a number of laboratories has established that the fish P-450 dependent MFO system is similar to the mammalian one and may be a simpler model for studying this phylogenetically primitive P-450 gene family. (See also W90-05812) (Lantz-PTT)
W90-05817

ENZYMES INVOLVED IN METABOLISM OF PAH BY FISHES AND OTHER AQUATIC ANIMALS: HYDROLYSIS AND CONJUGATION ENZYMES (OR PHASE II ENZYMES).
Oregon State Univ., Corvallis. Dept. of Biochemistry and Biophysics.
G. L. Foureman.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 185-202, 1 fig, 5 tab, 128 ref.

Descriptors: *Bioaccumulation, *Enzymes, *Fate of pollutants, *Fish, *Metabolism, *Polycyclic aromatic hydrocarbons, Aquatic animals, Biochemistry, Chemical analysis, Epoxide hydrolase, Flounders, Glutathione transferase, Sulfotransferase.

Subsequent to oxidative processes, some polycyclic aromatic hydrocarbons (PAH) may undergo further metabolism by enzymes. The enzymes involved in this secondary metabolism include the glutathione S-transferases (GST), UDP-glucuronosyltransferases (UDPGT), and sulfotransferases. According to the classical definition, these are phase II enzymes which function to increase the polarity of the lipophilic xenobiotic (phase I metabolites of PAH) by conjugating it with the endogenous compounds indicated in the names of the enzymes; this increase in polarity makes phase II metabolites more readily excreted by the organism. The aquatic species examined appear to have a full complement of hepatic and extrahepatic phase II enzymes, although with lower activity than the well-characterized mammalian systems. The efficacy of phase II enzymes in aquatic species has been amply demonstrated by recent in vivo studies with PAH substrates, as appreciable concentrations of administered PAH were recovered as phase II conjugates. In comparing various hepatic phase II enzymes (EH, GST, UDPGT) in trout and seven terrestrial species, low values were observed for the trout enzymes relative to the terrestrial species. Beside anthropogenic factors, the environment itself imposes on the physiologies of aquatic organisms. The seasonal variations of phase I and II enzyme activities are due to the aquatic organism responding to these impositions. Routes of administration in experimental studies with fish include force-feeding of encapsultated material, associating the dose with sediment for bottom-dwelling fish, and aqueous exposure for free-swimming fish. The few studies that have carefully compared dosing routes have noted differences. However, all of the studies emphasize that wide interspecies variability may exist and that extrapolation of results with one species to different fish species could be complicated. In future studies, the route of exposure should be carefully chosen to reflect most clearly the habitat, physiology, and behavior of the individual species. (See also W90-05812) (Lantz-PTT)
W90-05818

METABOLIC ACTIVATION OF PAH IN SUBCELLULAR FRACTIONS AND CELL CULTURES FROM AQUATIC AND TERRESTRIAL SPECIES.
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
U. Varanasi, M. Nishimoto, W. M. Baird, and T. A. Smolarek.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 203-251, 12 fig, 5 tab, 149 ref. Public Health Service Grant Nos. CA40228 and CA28825.

Descriptors: *Fate of pollutants, *Laboratory methods, *Metabolism, *Polycyclic aromatic hydrocarbons, *Tissue culture, *Toxicity, Benzenes, Benzopyrene, Biochemistry, Biodegradation, Detoxification, Microbiological studies.

Analyses of polycyclic aromatic hydrocarbon (PAH) metabolism in both subcellular fractions and cell cultures from a number of species of aquatic organisms, have demonstrated the ability of many aquatic organisms to metabolize PAH. These studies have demonstrated that similar metabolites are formed from benzo(a)pyrene (BaP) in both microsomal preparations and cell cultures from aquatic and terrestrial organisms, but the proportions of particular metabolites formed differ greatly between species. Studies with subcellular fractions have shown the regiochemical and stereochemical properties of xenobiotic metabolizing enzymes in terrestrial and fish species. Species-specific differences such as relative content and activity of individual enzymes may have significant implications in the activation of PAH into mutagenic and carcinogenic metabolites. The absence of phenobarbital-inducible isozymes of cytochrome P450 in fish shifts the balance of metabolism to benzo-ring metabolites of BaP. Cell cultures derived from a number of species of fish form high proportions of conjugated hydrocarbon metabolites. The formation of high levels of the glucuronic acid conjugate of BaP-7,8-diol in cell cultures from several species of fish, and the low level of binding of BaP to DNA in these cultures, may indicate that some fish tissues are able to detoxify this metabolite through glucuronide conjugation. Studies of the biological effects of PAH on fish cell cultures have demonstrated the induction of cytotoxicity, DNA damage, chromosomal damage, and mutations. Thus, studies which combine the analysis of PAH metabolism, DNA binding, and the induction of specific biological effects, should provide a valuable method for establishing the role of specific metabolic pathways in the activation and detoxification of PAH in aquatic organisms. The data indicate the value of both subcellular fraction studies and cell culture studies for determining how PAH are metabolized in aquatic species, and how they induce biological effects in these species. (See also W90-05812) (Lantz-PTT)
W90-05819

CONTRIBUTION OF ATMOSPHERIC NITRATE DEPOSITION TO NITRATE LOADING IN THE CHESAPEAKE BAY.
Versar, Inc., Columbia, MD.
M. Tyler.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-163281. Price codes: A03 in paper copy, A01 in microfiche. Report No. AD-88-7, December 1988. 29p, 1 fig, 4 tab, 30 ref, 2 append. Maryland Department of Natural Resources Contract PR86-043-01(88).

Descriptors: *Acid rain, *Air pollution, *Chesapeake Bay, *Nitrates, *Nutrients, *Path of pollutants, *Water pollution sources, Cropland, Fate of pollutants, Forests, Land use, Pastures, Urban areas.

Recent studies have suggested that nitrate introduced into the Chesapeake Bay via atmospheric deposition may be a significant source of excess nutrients. In order to determine if concerns about atmospheric deposition are justified, modeled estimates of wetfall nitrate deposition over the Chesapeake Bay basin, based on monitoring data collected in 1984, were used to estimate basin-wide nitrate loading (1.3 times 10 to the 8th power kg) over the land area of the basin. Estimates of transfer coefficients and nitrate loadings to the Bay for various land use categories were also calculated, using figures developed by the EPA Chesapeake Bay Program: forest (0-4.8%); pastureland (0.04-6.3%); residential (4.3-38%); and cropland (0.03-24%). Point source loading estimates from EPA were then used to estimate total annual nitrate loading to the Bay (280 million to 790 million kg). Using the minimum and maximum of both the atmospheric nitrate deposition and the total nitrate loadings, the percentage of total nitrate loading to the Bay attributable to atmospheric deposition was on the order of 25%. Great uncertainty in nitrate input estimates contributes to the wide range of input values used in the calculations. The conservative nature of assumptions made in developing these figures suggests that the actual percentage contribution of atmospheric nitrate deposition may be lower than the estimated value. (Author's abstract)
W90-05823

NEW YORK HARBOR WATER QUALITY SURVEY 1987.
New York City Dept. of Environmental Protection, Wards Island. Water Quality Section.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-147276. Price codes: A06 in paper copy, A01 in microfiche. 152p, 25 ref, 17 append.

Descriptors: *Hudson River, *Hydrologic data collections, *New York Harbor, *Water pollution sources, *Water quality, Ammonia, Bacteria, Biochemical oxygen demand, Boron, Cadmium, Chromium, Coliforms, Copper, Cyanide, Dissolved oxygen, East River, Hydrocarbons, Lead, Mercury, Nickel, Phosphorus, Raritan River, Silver, Surveys, Zinc.

New York City's Department of Environmental Protection monitored 52 stations for ten weeks of the 1987 summer to provide the 78th year of the NY Harbor Water Quality Survey. Significant long-term improvements in dissolved oxygen (DO), bacteria, biochemical oxygen demand (BOD), ammonia, and lead were detected at most sites. A weak, but significant harborwide increasing trend in total phosphorus, and scattered decreases in copper and mercury, were also detected. Harborwide, 79% and 94% of the 52 stations tested were within total and fecal coliform state standards, respectively; violations were confined to Flushing Bay, Jamaica Bay, and near the Raritan River. The most dramatic improvements occurred in the Hudson River and Lower East River, coinciding with the operation of the newly constructed North River and Red Hook Water Pollution Control Plants. Average DO met state standards at 39 of 52 sites, although most sites contravened standards at least once. The percentage of stations in compliance with each metal standard for 1986 and 1987 (respectively) is as follows: cadmium (75% and 50%), chromium (100% and 100%), copper (0% and 19%), lead (8% and 12%), mercury (0% and 60%), nickel (15% and 27%), zinc (100% and 16%), and silver (100% and 100%). Special sampling for cyanide and boron revealed low levels. Limited sampling for organochlorine pesticides and chlorinated hydrocarbons showed no violations of standards. Significant rain events were associated with order-of-magnitude increases in coliforms, and decreases of up to 1.5 mg/L DO in several Harbor branches. Correlation and factor analyses revealed significant relationships between many conventional parameters, nutrients, metals, and sediments concentrations. (Author's abstract)
W90-05824

ENVIRONMENTAL MONITORING MASTER SAMPLING SCHEDULE: JANUARY-DECEMBER 1989.

Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W90-05826

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM STATISTICAL AND ANALYTICAL SUPPORT CONTRACT: FINAL REPORT--VOLUME I.

Martin Marietta Environmental Systems, Columbia, MD.
For primary bibliographic entry see Field 5G.
W90-05829

ROCKY MOUNTAIN ACID DEPOSITION MODEL ASSESSMENT: ACID RAIN MOUNTAIN MESOSCALE MODEL (ARM3).

Systems Applications, Inc., San Rafael, CA.
R. E. Morris, R. C. Kessler, S. G. Douglas, K. R. Styles, and G. E. Moore.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-124408. Price codes: A14 in paper copy, A01 in microfiche. Report No. EPA/600/3-88/042, November 1988. 298p, 21 fig, 11 tab, 88 ref, 2 append. EPA Contract 68-02-4187.

Descriptors: *Acid rain, *Computer models, *Model studies, *Rocky Mountains, *Water pollution sources, Air pollution, Alpine regions, Distribution patterns, Meteorology, Mountains, Nitrogen, Sulfur, Wind.

The Acid Rain Mountain Mesoscale Model (ARM3) is a mesoscale acid deposition/air quality model developed to calculate incremental acid deposition (sulfur and nitrogen species) and pollutant concentration impacts in complex terrain. Development of the ARM3 was based on comments from western regulatory agencies which required an acid deposition/air quality model to estimate long-term sulfur and nitrogen deposition and short-term PSD pollutant concentration impacts at mesoscale distances (5 to 200 km). The ARM3 is designed to simulate long-term acid deposition and pollutant concentrations for periods up to a year by stepping through the year at time steps of an hour or less. Although the model was primarily designed for simulating impacts in regions within the Rocky Mountains, it can be applied anywhere provided the proper inputs are prepared. However, since the model uses pseudo first-order chemistry, it is not suitable for applications in regions dominated by nonlinear chemistry. The ARM3 consists of two main components: a mesoscale meteorological model and a Lagrangian acid deposition/air quality model. The mesoscale meteorological model contains a new diagnostic wind model that accounts for the kinematic, deflection, and thermal effects that alter the flow fields due to complex terrain. The Lagrangian acid deposition/air quality model has the following attributes: two options for calculating plume height above ground, three options for determining dispersion rates including one that accounts for terrain roughness; a dry deposition algorithm based on the resistance approach; wet deposition using the scavenging coefficient approach; and two options for calculating chemical transformation. (Author's abstract)
W90-05831

PATHOGENIC AMOEBAE IN NATURAL THERMAL WATERS OF THREE RESORTS OF HIDALGO, MEXICO.

Project of Conservation and Improvement of the Environment, Los Reyes (Mexico). Unit of Interdisciplinary Research of Health and Education Sciences.
F. Rivera, F. Lares, E. Gallegos, E. Ramirez, and P. Bonilla.
Environmental Research ENVRAL, Vol. 50, No. 2, p 289-295, December 1989. 2 fig, 1 tab, 21 ref.

Descriptors: *Amebas, *Bioindicators, *Pathogens, *Pollutant identification, *Public health, *Water analysis, Amoebic encephalitis, Culturing techniques, Mexico, Recreation.

In a search for free-living amoebae, seven water samples from three thermal water bathing resorts in Tecozautla, Hidalgo, were analyzed during December 1984. The samples were concentrated by filtration and centrifugation, and inoculated later on monoxenic and axenic media. The identification of the isolates was performed by morphology and isoelectric focusing of isoenzymes and total proteins. Thirty-three strains of free-living amoebae belonging to the genera Naegleria, Acanthamoeba, and Willaertia were isolated. Twenty of these strains belonged to the Naegleria genus, 16 of them were classified as Naegleria spp., and 2 were classified as Naegleria lovaniensis. Noteworthy was the finding of two pathogenic strains of the species Naegleria australiensis. N. australiensis and N. Lovaniensis may be considered good indicator organisms, since they live in the same environmental conditions as N. fowleri, the agent of primary amoebic encephalitis (PAM). On the other hand, amoebae other than Naegleria were isolated and identified as Acanthamoeba castellanii (two strains), Acanthamoeba lugdunensis (one strain), which proved to be pathogenic when tested in mice. Nine more pathogenic strains of the genus Acanthamoeba spp. were isolated together with one strain of Willaertia magna, a thermophilic nonpathogenic amoeba. The chlorination and periodical surveillance of water resorts like the one studied is recommended, in order to prevent the appearance of more cases of PAM or other human diseases associated with pathogenic Acanthamoeba spp. (Author's abstract)
W90-05833

ALUMINIUM DIS-EQUILIBRIUM SOLUBILITY CONTROLS IN SCOTTISH ACIDIC CATCHMENTS.

Macaulay Land Use Research Inst., Aberdeen (Scotland).
R. McMahon, and C. Neal.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 1, p 21-28, February 1990. 1 fig, 4 tab, 17 ref.

Descriptors: *Acid rain effects, *Acid streams, *Acidic soils, *Aluminum, *Scotland, *Water chemistry, *Weathering, Hydrogen ion concentration, Organic matter, Soil chemistry, Soil horizons, Solubility, Thermodynamics, Water depth.

Soil and stream water aluminum and hydrogen ion data are presented for three Scottish catchments that are both acidic and acid sensitive. Stream waters have pH values ranging from 3.9 to 7.1 and aluminum concentrations in the range 0.07 to 129 microM/L. Within the soils hydrogen ion concentrations decline with depth, being highest in the organic horizons and lowest in the inorganic horizons. Mean hydrogen ion concentrations vary markedly from site to site (hydrogen ion ranges from 12 to 111 and from 9 to 72 microM/L in the upper and lower soils respectively). Correspondingly dissolved aluminum varies with depth and from site to site (range from 2 to 21 and from 8 to 17 microM/L in the upper and lower soils respectively). Thermodynamic analysis of these data sets show that simple aluminum hydroxide and aluminum hydroxysulfate solubility relationships are inoperative in the stream and soil zones. Dis-equilibrium 'weathering' processes are inferred, even in the case where aluminum hydroxide (gibbsite) is found within the catchment. (Author's abstract)
W90-05836

PESTICIDE RESIDUES IN MILK AND FISH SAMPLES COLLECTED FROM TWO EGYPTIAN GOVERNORATES.

Central Agricultural Pesticides Lab., Cairo (Egypt).
S. M. Dogheim, E. N. Nasr, M. M. Almaz, and M. M. El-Tohamy.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 73, No. 1, p 19-21, 1990. 5 tab, 6 ref.

Descriptors: *Egypt, *Pesticide residues, *Pesticides, Fish, Milk, Monitoring, Pollutant identification, Tissue analysis.

Because of the intensive use of pesticides in Egypt, country-wide residue monitoring programs must be established that can cover all the Egyptian Governorates exposed to pesticide treatments. To do so, limited programs must be adopted first, so that current situations and future needs for improved programs are identified. Results are reported from a limited monitoring program, which started in 1985 in one governorate and than expanded to include another in 1986. Fish and milk samples were the commodities selected for residue analysis. The results showed that milk samples collected from Beni-Suef Governorate in 1986 had lower levels of organochlorine residues compared to those collected in 1985. Residues in boltifish and catfish samples in 1986 were much higher than those detected in 1985. In comparison with Beni-Suef Governorate, and contrary to expectations, milk derived from Fayoum Governorate in 1986 was more contaminated with pesticides. While the amount of residues in boltifish was comparatively higher, catfish samples were less contaminated. (Author's abstract)
W90-05841

BIOACCUMULATION OF CHLORINATED HYDROCARBONS BY THE MAYFLY (HEXAGENIA LIMBATA) IN LAKE ST. CLAIR.

Windsor Univ. (Ontario). Great Lakes Inst.
F. A. P. C. Gobas, D. C. Bedard, J. J. H. Ciborowski, and G. D. Haffner.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 581-588, 1989. 1 fig, 3 tab, 20 ref.

Descriptors: *Bioaccumulation, *Chlorinated aromatic compounds, *Mayflies, *Path of pollutants, *Polychlorinated biphenyls, Model studies, Rate constants, Sediment contamination.

Concentrations of six PCB congeners, octachlorostyrene, and penta-chlorobenzene and hexa-chlorobenzene were measured in sediments and in resident in situ mayfly populations (Hexagenia limbata) at a location in Lake St. Clair from July to September, 1987. Observed mayfly/sediment con-

~~centrations~~ ratios varied from 0.14 for pentachlorobenzene to 0.71 for PCB-153, and were linearly correlated with octanol/water partition coefficient (Kow) when expressed on a logarithmic basis. A chemical equilibrium model of sediment-organism interactions predicting a mayfly/sediment concentration ratio of 0.5 is shown to be in good agreement with the field observations, particularly for the higher compounds. A dynamic model gives a more realistic description of organic chemical uptake and bioaccumulation in the mayfly. However, when calibrated by rate constants derived from laboratory experiments, this model tends to overestimate mayfly sediment concentration ratios by approximately a factor of 10. (Author's abstract)
W90-05844

TOXICOKINETICS OF DDE, BENZO(A)PYRNE, AND 2, 4, 5, 2', 4', 5'-HEXACHLOROBIPHENYL IN PONTOPOREIA HOYI AND MYSIS RELICTA.
Michigan Univ., Ann Arbor. Great Lakes Research Div.
M. S. Evans, and P. F. Landrum.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 589-600, 1989. 4 fig, 2 tab, 33 ref. EPA Grant No. R-812311-01-0.

Descriptors: *Amphipods, *Benzopyrene, *Bioaccumulation, *Crustaceans, *DDE, *Path of pollutants, *Pesticides, *Polychlorinated biphenyls, *Shrimp, Comparison studies, Elimination rate, Partition coefficients.

The toxicokinetics of DDE, benzo(a)pyrene (BaP), and 2, 4, 5, 2', 4', 5'-hexachlorobiphenyl (HB) were followed for the amphipod, Pontoporeia hoyi, and the mysid, Mysis relicta. Pontoporeia and Mysis had similar uptake clearances for DDE (mean = 79.2 mL/g/h and 46.0 mL/g/h, respectively), BaP (mean = 75.9 mL/g/h and 39.9 mL/g/h, respectively), and HB (mean = 53.5 mL/g/h and 57.5 mL/g/h, respectively) compounds with log octanol-water partition coefficients ranging from 5.7 to 6.7. Amphipods and mysids were most efficient at eliminating BaP (mean elimination rate constant = -0.0017/h and -0.0047/h, respectively) and least efficient at eliminating HB (mean = -0.0008/h and -0.0001/h respectively). Amphipods were more efficient than mysids in eliminating DDE (mean = -0.0010/h and -0.0005/h, respectively) and HB while mysids were more efficient at eliminating BaP. Because elimination rate constants for DDE, BaP, and HB were substantially different between P. hoyi and M. relicta, there were substantial differences in the calculated bioconcentration factors (BCFs). Amphipods tended toward larger BCFs than mysids for BaP (mean = 48,582 and 8,496, respectively) but lower BCFs for DDE (mean = 95,629 and 138,760, respectively) and HB (mean = 101,663 and 442,231, respectively) than mysids. (Author's abstract)
W90-05845

LIPID COMPOSITION RELATED TO SIZE AND MATURITY OF THE AMPHIPOD PONTOPOREIA HOYI.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W90-05846

PATTERNS OF ORGANIC CONTAMINANT ACCUMULATION BY FRESHWATER MUSSELS IN THE ST. CLAIR RIVER, ONTARIO.
Windsor Univ. (Ontario). Great Lakes Inst.
B. W. Muncaster, D. J. Innes, P. D. N. Hebert, and G. D. Haffner.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 645-653, 1989. 6 fig, 3 tab, 20 ref.

Descriptors: *Bioaccumulation, *Bioindicators, *Chlorinated aromatic compounds, *Mollusks, *Mussels, *Organic pollutants, Seasonal variation, St Clair River, Temporal variation, Vertical variation.

Individuals of the freshwater mussel, Elliptio complanata, were exposed to organic contaminants at four sites in and adjacent to the St. Clair River for periods ranging from 1 to 12 weeks in 1986 and 1987. Accumulation patterns for hexachlorobenzene (HCB) and octachlorostyrene (OCS) paralleled those expected on the basis of their tenfold difference in octanol-water partition coefficients, with mean HCB concentrations peaking at 3.8 ng/g after 3 weeks, while OCS burdens peaked at 19.6 ng/g after 9 weeks. Mussels deployed in the St. Clair River and Chenal Ecarte had similar body burdens, indicating that a significant portion of the St. Clair River contaminant plume is deflected into Chenal Ecarte. Vertical heterogeneity of contaminant accumulation in the water column was minimal, but temporal heterogeneity was substantial. Weekly sampling revealed erratic shifts in body burdens which may correspond to short-term fluctuations in contaminant discharge. Seasonal shifts in contaminant levels observed in 1986 were absent in 1987, while a halving of HCB and OCS body burdens was noted between the 2 years. Results indicate that a fixed exposure period is inadequate to characterize organic contaminant levels, both as a result of chemical specific accumulation patterns and temporal heterogeneity. (Author's abstract)
W90-05850

DETECTING ACID PRECIPITATION IMPACTS ON LAKE WATER QUALITY.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 7A.
W90-05860

USE OF EXPERIMENTAL ECOSYSTEM IN REGULATORY DECISION MAKING.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 5A.
W90-05861

ENVIRONMENTAL MONITORING AT HANFORD, WASHINGTON, USA: A BRIEF SITE HISTORY AND SUMMARY OF RECENT RESULTS.
Battelle Pacific Northwest Labs., Richland, WA. Office of Hanford Environment.
For primary bibliographic entry see Field 5A.
W90-05863

DEVELOPMENT OF A MIXED SOLUTION TECHNIQUE FOR A DYNAMIC RIVER QUALITY MODEL.
Salford Univ. (England). Dept. of Civil Engineering.
R. J. Norreys, C. P. Crockett, R. W. Crabtree, and J. P. Lumbers.
Environmental Technology Letters ETLEDB, Vol. 10, No. 11, p 977-988, November 1989. 9 fig, 15 ref.

Descriptors: *Model studies, *Path of pollutants, *River flow, *Streamflow, Spill Pollution Response Assessment Tech, Velocity, Water pollution control.

Solution methods used in the development of a simple, mixed solution technique river impact model, are described. The Spill Pollution Response Assessment Technique (SPRAT) model routes a flow wave down a river reach using an Eulerian reference frame. A simple velocity/flow relationship is used to obtain a velocity field from the derived flow field. A Lagrangian reference frame is superimposed upon the derived velocity field and this is then used to route a pollutant wave down the reach. The SPRAT model was shown to offer a theoretically satisfactory method for routing flood and associated pollutant waves down an idealized river reach. The advection solution is capable of transporting a pollutant wave down a reach without instability or numerical dispersion. The dispersion component provides a good solution to the diffusion equation. Tests on the combined model have shown that errors in water volume and pollutant mass retention were less than 0.1% for a river reach of 20km length. Although the proposed solutions have a number of disadvantages and simplifications, the low level of data required to run the model should compensate for these shortcomings. (Author's abstract)
W90-05870

RATES OF ACID DEPOSITION AND THEIR INTERACTION WITH FOREST CANOPY AND SOIL IN TWO BEECH FOREST ECOSYSTEMS ON LIMESTONE AND TRIASSIC SANDSTONE SOILS IN N. GERMANY.
Goettingen Univ. (Germany, F.R.). Abt. Bodenkunde und Waldernahrung.
S. P. Sah, and K. J. Meiwes.
Environmental Technology Letters ETLEDB, Vol. 10, No. 11, p 995-1002, November 1989. 3 tab, 16 ref.

Descriptors: *Acid rain effects, *Forest soils, *Forests, *West Germany, Acidic soils, Buffer capacity, Calcareous soils, Hydrogen ion concentration, Leaching, Toxins.

From deposition measurements in a beech forest on limestone soil it was calculated that about 60% of deposited hydrogen ions from the atmosphere were buffered through the forest canopy prior to leaching onto the soil surface, compared to only 33% for the acid soil ecosystem. Soil internal proton production, as expected, was lower (1.5 keq/ha/yr) in the acid soil than the calcareous soil ecosystem (15.3 keq/ha/yr). It can be concluded that the rate of hydrogen-ion buffering by the forest canopy is chiefly dependent upon the soil type. The effect of acid deposition upon acid soil can cause 90% of total acid production, whereas it is much lower (10%) on calcareous soil. In calcareous soil, 90% of total acid production is chiefly of internal origin (i.e. mainly due to leaching of bicarbonate ions and to some extent 'excess cation' accumulation in biomass increment). The neutralization of acid load in the soil is dependent on the base content of the soil. In calcareous soil the acid neutralization takes place without the release of considerable amounts of acid cations such as aluminum, but in acid soil deposited strong acids cause the release of these toxics, resulting in soil acidification. (Author's abstract)
W90-05871

SURVEILLANCE: THE FOUNDATION FOR CONTROL AND ELIMINATION OF DRACUNCULIASIS IN AFRICA.
WHO Collaborating Center for Research, Training, and Control of Dracunculiasis, Atlanta, GA.
For primary bibliographic entry see Field 7A.
W90-05873

GULF OF MEXICO HYDROCARBON SEEP COMMUNITIES: PART III. AROMATIC HYDROCARBON CONCENTRATIONS IN ORGANISMS, SEDIMENTS AND WATER.
Texas A and M Univ., College Station. Dept. of Oceanography.
T. L. Wade, M. C. Kennicutt, and J. M. Brooks.
Marine Environmental Research MERSDW, Vol. 27, No. 1, p 19-39, 1989. 2 fig, 1 tab, 25 ref.

Descriptors: *Bioaccumulation, *Fate of pollutants, *Gulf of Mexico, *Hydrocarbons, *Oil pollution, Aquatic life, Benthos, Carbon, Chemosynthesis, Sulfur cycle.

Organism tissues from areas of natural oil seepage contain significant amounts of polynuclear aromatic hydrocarbons (PAH). Higher concentrations are found in sedentary organisms (i.e. mussels and tube worms) than in more mobile species (i.e. fish). The PAH distributions indicate that the seep organisms are exposed to sediment and/or water associated PAH. The concentration and composition of PAH in sedentary organisms are similar to that of an oyster from a coastal site indicating similar mechanisms of PAH uptake, depuration and accumulation. Tissue PAH concentrations indicate that these organisms are chronically exposed to high levels of petroleum in their environments and yet thriving communities are present at these locations. Microbial biomass in these seep areas is also substantially enhanced, and the carbon isotopic composition of organism tissues from higher trophic

levels reflects the incorporation of bacterial biomass. The sedimentary sulfur cycle is heavily influenced by the process of natural oil and gas seepage and plays a key role in maintaining these communities. The primary source of isotopically light carbon to the system can be solely derived from chemosynthesis (hydrogen sulfide or methane). The role of degraded oil as a partial source of light carbon to some organisms cannot be ruled out. (Author's abstract)
W90-05876

INDUCED CYTOCHROME P-450 IN FUNDULUS HETEROCLITUS ASSOCIATED WITH ENVIRONMENTAL CONTAMINATION BY POLYCHLORINATED BIPHENYLS AND POLYNUCLEAR AROMATIC HYDROCARBONS.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
A. A. Elskus, and J. J. Stegeman.
Marine Environmental Research MERSDW, Vol. 27, No. 1, p 31-50, 1989. 2 fig, 2 tab, 53 ref.

Descriptors: *Bioaccumulation, *Fish physiology, *Hydrocarbons, *Path of pollutants, *Polychlorinated biphenyls, Cytochrome P-450, Rhode Island.

Fundulus heteroclitus were collected from two sites in Rhode Island during the non-spawning season and analyzed from hepatic monooxygenase activities and for whole-body concentrations of polychlorinated biphenyls (PCB) and polynuclear aromatic hydrocarbons (PAH). Microsomal protein, total spectral cytochrome P-450 and cytochrome b5 content did not differ between Seekonk River and Succotash Salt Marsh fish. Ethoxyresorufin O-deethylase activity was significantly higher (3-fold) in Fundulus from the Seekonk River than in fish from Succotash Salt Marsh. Similarly, levels of the immunodetectable homolog of P450 E in Fundulus, a representative of the major PAH-inducible P-450 form (P450IA1) in teleosts, were higher in fish from the Seekonk River. In contrast, rates of aldrin epoxidase (AE) activity were the same in fish from the two sites. Concentrations of PCB were 1000-fold, and PAH 60-fold, greater in Seekonk River sediment than in Succotash Salt Marsh sediment. The bioavailability of these contaminants in not known. (Author's abstract)
W90-05877

ORGANOTIN COMPOUNDS, FOULING AND THE MARINE ENVIRONMENT.
Nigerian Inst. for Oceanography and Marine Research, Lagos.
E. O. Oyewo.
Ocean & Shoreline Management OSMAE6, Vol. 12, No. 4, p 285-294, 1989. 37 ref.

Descriptors: *Antifoulants, *Marine pollution, *Organotin compounds, *Water pollution sources, Aquatic life, Toxicity.

Routine shipping, boating and ocean engineering activities present surfaces on which fouling organisms can settle and create economic, operational and aesthetic problems. Tri-organotin-based antifouling preparations are often applied to these surfaces, leading to the inevitable introduction of tri-organotins into the marine environment. After critically considering several aspects of the behavior, toxicity, toxicology, known and potential interactions of tri-organotins with biotic and abiotic components of the marine environment, it is concluded that tri-organotins are potentially hazardous. Even where the environmental behavior is known, a surprise factor is often present. The introduction of anything foreign, particularly chemicals, into the marine environment clearly needs to be done with caution and ideally with a sound understanding of both the short-term and long-term effects. (Author's abstract)
W90-05878

HETEROTROPHIC NANNO- AND MICROPLANKTON IN COASTAL WATERS OF THE WESTERN INDIAN OCEAN.
Akademiya Nauk SSSR, Moscow. Inst. Okeanologii.
For primary bibliographic entry see Field 2L.
W90-05879

3-D FINITE ELEMENT TRANSPORT MODELS BY UPWIND PRECONDITIONED CONJUGATE GRADIENTS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
G. Pini, G. Gambolati, and G. Galeati.
Advances in Water Resources AWREDI, Vol. 12, No. 2, p 54-58, June 1989. 7 fig, 18 ref.

Descriptors: *Convection, *Dispersion, *Finite element method, *Groundwater movement, *Model studies, *Path of pollutants, Computer models, Groundwater pollution, Mathematical analysis, Mathematical models, Numerical analysis.

Numerical solutions to the dispersion-convection equation in subsurface systems have relied extensively on the Galerkin approach mainly because of its high versatility in handling irregular geometries. In convection-dominated problems this approach leads to (1) unstable solutions with oscillating behavior, and (2) artificial dispersion which causes smearing of the simulated contaminant plume. Mathematical approaches to adjust for these effects in three-dimensional finite element simulations commonly rely upon upwinding schemes and require a refined mesh with a large number of nodes, making a cost-effective solution difficult to obtain. A class of iterative solvers, based upon the preconditioned conjugate gradients (CG) and proven to be robust and efficient in two-dimensional applications, are extended to three-dimensional problems. Solvers tested are ORTHOMIN(k), the Generalized Conjugate Residual GCR(k), and the Minimum Residual (MR). Results of three test problems indicate convergence of the upwind preconditioned solvers is quite good, and the solution is obtained even when failure to converge occurs with the standard Galerkin approach. GCR(k) appears to be the most robust, while MR is the most economical in the vast majority of cases and is preferred when the Peclet and Courant numbers are not too far from the stability limits. Upwinding improves the performance of the solvers but also tends to increase artificial dispersion, and therefore must be managed with care. (Tappert-PTT)
W90-05882

TRENDS IN PARTICULATE DEPOSITION AND PRECIPITATION CHEMISTRY AT LEEDS (U.K.) 1907-1987.
Leeds Univ. (England). Dept. of Fuel and Energy.
A. G. Clarke, D. R. Lambert, and M. J. Willison.
Atmospheric Environment Part B: Urban Atmosphere AEBAE5, Vol. 24B, No. 1, p 159-169, January 1990.

Descriptors: *Acid rain, *Air pollution, *Chemistry of precipitation, *Data interpretation, *Dry deposition, *England, *Particulate matter, *Precipitation, *Water pollution sources, Ammonia, Chlorides, Coal, Deposition, Dusts, History, Industrial wastes, Nitrates, Path of pollutants, Sulfur compounds.

A review of available data on the composition of precipitation and the deposition rates of various species has been carried out for the city of Leeds in Northern England covering the years 1907-1987. The information for three typical sites representing heavily industrialized, suburban and rural locations is compared. Parameters studied include smoke and sulfur dioxide concentrations, dust deposition, sulfur, nitrogen, chloride and acidity. The exceptionally high deposition rates and large urban/rural differences of the early years have now disappeared. Perhaps surprisingly, the parameter which has changed least is net acidity. The highly acidic deposits of sulfates and chlorides from coal combustion before 1930 were counterbalanced by correspondingly high deposition rates of ammonia and alkaline dusts. The only major parameter which shows a significant increase is nitrate. (Author's abstract)
W90-05900

RAINWATER COMPOSITION IN ATHENS, GREECE.
Athens Univ. (Greece). Lab. of Climatology.
J. G. Dikaikos, C. G. Tsitouris, P. A. Siskos, D. A. Melissos, and P. Nastos.
Atmospheric Environment Part B: Urban Atmosphere AEBAE5, Vol. 24B, No. 1, p 171-176, January 1990. 1 fig, 3 tab, 30 ref.

Descriptors: *Acid rain, *Air pollution, *Chemistry of precipitation, *Greece, *Path of pollutants, *Sulfur compounds, Anions, Cations, Chemical analysis, Data interpretation, Deposition, Nitrogen compounds, Precipitation, Statistical analysis, Sulfuric acid, Water sampling.

Acid precipitation, a major environmental problem, was investigated in Athens, Greece. Wet precipitation-only samplers were used to collect wet deposition at two sites in the Athens basin, Greece for the period March 1986 to February 1987. Concentration of major cations, hydrogen, ammonium, sodium, calcium and magnesium (H(+), NH4(+), Na(+), Ca(++) and Mg(++)), and major anions, chloride, nitrate and sulfate (Cl(-), NO3(-) and SO4(--)), were determined for the first time in rainwater samples in Greece. Bicarbonate concentrations were calculated. The majority of rain collected had a neutral or alkaline character. Acidity was due to the of sulfuric acid (H2SO4) and nitric acid (HNO3). The relative importance of natural and anthropogenic sources were estimated by a chemical balance. Statistical analysis of the correlation between the concentration of chemical species confirms the influence of natural and anthropogenic sources. In all samples, SO4(--) concentrations exceed NO3(-) concentration despite the dominance of low sulfur oil burning in the region. The wet flux of sulfur was calculated to be 0.34 g/sq m/acre. (Author's abstract)
W90-05901

INFLUENCE OF ATMOSPHERIC TRANSPORT ON PRECIPITATION CHEMISTRY AT TWO SITES IN THE MIDWESTERN UNITED STATES.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. L. Moody, and P. J. Samson.
Atmospheric Environment ATENBP, Vol. 23, No. 10, p 2117-2132, October 1989. 8 fig, 6 tab, 30 ref.

Descriptors: *Acid rain, *Air pollution, *Chemistry of precipitation, *Meteorological data collection, *Path of pollutants, *Weather patterns, Air masses, Chemical analysis, Deposition, Ions, Multivariate analysis, Precipitation, Variability.

To determine how much of the chemical variability in precipitation could be related to transport differences, cluster analyses of two-dimensional mixed layer back trajectory data were used to classify precipitation events into subgroups representing similar transport patterns. Trajectories arriving at two different sites, Rockport, IN, and Gaylord, MI, were clustered to identify events occurring with similar transport patterns. It was found that certain transport situations resulted in significantly higher concentrations and depositions of the major ions hydrogen, sulfate, nitrate and ammonium (H(+), SO4(-), NO3(-) and NH4(+)). At Rockport, the greatest fraction of acid deposition was associated with low wind speeds. At Gaylord, transport direction played a greater role than transport speed in influencing precipitation composition. Results presented here suggest that 10 to 40% of the variability in ion concentrations may be related to differences in atmospheric transport. The residual variation in concentrations was correlated with differences in the occurrence of upwind precipitation, precipitation type, and variation in precipitation amount. (Author's abstract)
W90-05902

ATMOSPHERIC DEPOSITION OF PERSISTENT POLLUTANTS GOVERNS UPTAKE BY ZOOPLANKTON IN A POND IN SOUTHERN SWEDEN.
Lund Univ. (Sweden). Dept. of Ecology.
P. Larsson.
Atmospheric Environment ATENBP, Vol. 23, No. 10, p 2151-2158, October 1989. 5 fig, 47 ref.

Descriptors: *Air pollution, *DDT, *Daphnia, *Fallout, *Lindane, *Polychlorinated biphenyls, *Ponds, *Water pollution sources, *Zooplankton, Bioaccumulation, Chlorinated hydrocarbons, DDD, DDE, Deposition, Path of pollutants, Population exposure, Precipitation, Seasonal variation, Sweden.

Although our knowledge regarding the atmospheric transport of chlorinated hydrocarbons is extensively studied, very little is known about the uptake of transported substances by organisms as well as their biological effects in the ecosystem. The atmospheric fallout of polychlorinated biphenyls (PCBs), epsilon-DDT and lindane (gamma-hexachlorocyclohexane; g-HCH) to a pond in southern Sweden was studied in relation to uptake by freshwater zooplankton. The extent of the atmospheric deposition of PCBs and lindane was reflected in the uptake by the zooplankton; high deposition in the spring and autumn results in high uptake by the organisms while a lower uptake during summer was a result of lower deposition. The atmospheric deposition of epsilon-DDT was dominated by p,p-DDT, p,p-DDE and o,p-DDT, while p,p-DDE and p,p-DDD were dominant in zooplankton. These differences in epsilon-DDT composition are probably attributed to microbial conversion; as a result, levels in the zooplankton appeared not to be governed by atmospheric deposition. The availability of the previously airborne, persistent pollutants to zooplankton was a function of the compounds' chemical properties, e.g. water solubility, and the form of deposition. The results show that atmospheric deposition is an important route by which persistent pollutants are transported to Holarctic, aquatic ecosystems. (Author's abstract)
W90-05903

CHARACTERISTIC TIME TO ACHIEVE INTERFACIAL PHASE EQUILIBRIUM IN CLOUD DROPS.

General Motors Research Labs., Warren, MI. Environmental Science Dept.
S. Kumar.
Atmospheric Environment ATENBP, Vol. 23, No. 10, p 2299-2304, October 1989. 1 fig, 2 tab, 17 ref.

Descriptors: *Acid rain, *Air-water interfaces, *Atmospheric water, *Chemistry of precipitation, *Cloud liquid water, *Cloud physics, *Path of pollutants, *Air pollution, Chemical reactions, Equilibrium, Fluid drops, Mathematical studies, Precipitation, Time series analysis, Water vapor.

The problem of gas absorption in a cloud drop for the case of a single isolated drop as well as for the case of a drop within a cloud is considered. Expressions for the characteristic times for achieving phase equilibrium between the gas-phase and liquid-phase pollutant concentrations at the air-water interface for the two cases are derived. According to the work reported here, for highly soluble gases the characteristic time for the case of an isolated drop as well as for the case of a drop within a cloud is directly proportional to the drop radius and inversely proportional to the accommodation coefficient of a gas. Furthermore, in the first case, the characteristic time is directly proportional to the solubility of the gas, while in the second case, it is independent of the solubility but inversely proportional to the liquid water content of the cloud. This problem has been considered previously, however, the expression in the literature is based on the concentration at the interface of semi-infinite liquid body and is not valid for a cloud drop. The findings in this paper disagree with those obtained from the expressions derived in the literature. In addition, for highly soluble gases, the expression in the literature predicts unrealistically large characteristic times for establishment of interfacial equilibrium. The reaction characteristic times for reactions of sulfur dioxide, hydrogen peroxide and ozone leading to the formation of sulfate ion (SO4(--)) within cloud drops are calculated and compared to the characteristic times, predicted by the expressions derived here, for establishment of interfacial equilibrium for these gases. The comparison shows that the establishment of interfacial equilibrium is a rapid process for all cases considered, and does not limit the chemical reactions leading for the formation of SO4(--) within cloud drops. (Author's abstract)
W90-05904

CHEMICAL COMPOSITION OF COASTAL STRATUS CLOUDS: DEPENDENCE ON DROPLET SIZE AND DISTANCE FROM THE COAST.

California Inst. of Tech., Pasadena. W.M. Keck Lab. of Environmental Engineering Science.
For primary bibliographic entry see Field 2K.
W90-05905

SEASONAL VARIATIONS IN SULFATE, NITRATE AND CHLORIDE IN THE GREENLAND ICE SHEET: RELATION TO ATMOSPHERIC CONCENTRATIONS.

Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.
C. I. Davidson, J. R. Harrington, M. J. Stephenson, M. J. Small, and F. P. Boscoe.
Atmospheric Environment ATENBP, Vol. 23, No. 11, p 2483-2493, November 1989. 7 fig, 34 ref. NSF Grant DPP-8618223.

Descriptors: *Acid rain, *Air pollution, *Arctic, *Avoidance, *Chlorides, *Greenland, *Ice, *Nitrates, *Path of pollutants, *Precipitation scavenging, *Sulfates, Aerosols, Deposition, Rime, Seasonal variation, Snow.

Samples from three snowpits near Dye 3 in South Greenland have been used to study seasonal variations in contaminant transport from the atmosphere to the Ice Sheet. The snowpits cover the years 1982 to 1987. The samples have been dated by comparing delta O18 (oxygen) values with meteorological data from Dye 3. Airborne concentrations of sulfate (SO4(--)) over the Ice Sheet have been estimated for the dates corresponding to each snowpit sample by statistically analyzing data from several air monitoring stations throughout the Arctic, and computing average values from the appropriate stations. Seasonal variations in concentrations in air, concentrations in snow, and mass-basis scavenging ratios (concentration in snow divided by concentration in air) have been identified. Results indicate that concentrations of SO4(--) in the air show a strong peak in late February, resulting from long-range transport of mid-latitude anthropogenic emissions, while those in the snow show a broad peak in January, February and March with smaller seasonal variation overall. The smaller variation in the snow is attributed in part to the effect of riming, which results in more efficient scavenging during warm weather when airborne concentrations are low. The importance of riming is also supported by the annual cycle in scavenging ratio which peaks in mid-summer coincident with maximum temperatures. In agreement with previous estimates, dry deposition appears to account for to 30% of the total SO4(--) in the snow. Concentrations of nitrate (NO3(-)) in the snow show a strong peak in summer; natural material from the stratosphere as well as anthropogenic emissions transported from the mid-latitudes may be responsible. Concentrations of chloride ion in the snow are maximum in January, with relatively high concentrations during October through March and a smaller peak in July. The winter peak is believed to reflect long-range transport of marine aerosol from North Atlantic storms, while the summer peak is attributed to seaspray from nearby coastal Greenland. (Author's abstract)
W90-05906

TRANSFORMATION AND LOSS OF NITRATE IN AN AGRICULTURAL STREAM.

Iowa State Univ., Ames. Dept. of Botany.
T. M. Isenhart, and W. G. Crumpton.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 123-129, December 1989. 1 fig, 2 tab, 30 reft. U.S. Dept. of the Interior and Iowa State Water Resources Research Institute Project No. G-1225-05.

Descriptors: *Agricultural runoff, *Biotransformation, *Fate of pollutants, *Iowa, *Nitrates, *Nitrogen removal, *Nonpoint pollution sources, *Stream pollution, Agricultural watersheds, Algal growth, Aquatic productivity, Dissolved oxygen, Fertilizers, Nutrient requirements, Respiration, Water temperature.

Bear Creek is a shallow, productive stream which enters the South Skunk River north of Ames, IA. In excess of 85 % of the South Skunk River watershed north of Ames is in intensive row crop agriculture; most of it receives annual nitrogen fertilizer applications. As a result, Bear Creek receives substantial non-point nitrogen loading, predominantly in the form of nitrate. Mass balances of nitrate nitrogen were determined for Bear Creek. Primary production and respiration of stream reaches were estimated from analyses of diurnal changes in dissolved oxygen and temperature. Substantial in-stream losses of nitrate were observed, averaging 0.66 g N/square m/day. The estimated nitrogen requirements to support observed rates of primary production ranged between 0.15 and 0.27 g N/square m/day. Laboratory investigations measuring nitrate nitrogen loss rates from stream water overlying intact sediment cores suggest that algal assimilation of inorganic nitrogen contributes to the overall nitrate decline in these systems. (Mertz-PTT)
W90-05926

EXPERT SYSTEM SURVEY ON BIODEGRADATION OF XENOBIOTIC CHEMICALS.

Environmental Protection Agency, Washington, DC. Office of Toxic Substances.
R. S. Boethling, B. Gregg, R. Frederick, N. W. Gabel, and S. E. Cambell.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 3, p 252-267, December 1989. 2 fig, 5 tab, 8 ref.

Descriptors: *Biodegradation, *Chemical wastes, *Fate of pollutants, *Toxic wastes, Aerobic degradation, Anaerobic degradation, Expert systems, Feasibility studies, Organic compounds, Polymers, Wastewater treatment.

To determine the feasibility of developing an expert system for biodegradability assessment, a survey was conducted in which biodegradation experts were asked to estimate rates and products of degradation for 50 chemicals. These chemicals, which varied widely in structure, were considered representative of the spectrum of premanufacture notice chemicals subject to EPA review under the Toxic Substances Control Act. There was substantial agreement among the 22 experts on both sites of initial attack and rates of degradation. The approximate order in which various groups were viewed as contributing to aerobic biodegradability is as follows: ester, amide, anhydride > hydroxyl > carboxyl, epoxide, site of unsaturation > benzene ring, methyl, methylene. Hydrolyzable groups, azo bonds, halogens, and nitro groups were preferred sites of anaerobic attack. Among the negative influences on aerobic biodegradability were molecular mass, branching, halogenation, and nitrogen heterocycles. Results also indicate that estimates of removal by biodegradation in aerobic wastewater treatment and time for aerobic ultimate and primary degradation were well correlated, and that the predictive value of such correlations could be improved using correction factors for certain classes of chemicals. The results lend support to existing rules of thumb, but also offer additional insight that will prove useful in designing a prototype system. (Author's abstract)
W90-05941

PRELIMINARY STUDY OF THE TRANSLOCATION OF ALDICARB ACROSS THE DUCK EGGSHELL.

Trinity Coll., Dublin (Ireland). Dept. of Pharmacology and Therapeutics.
P. L. Chambers, K. P. Twomey, and C. M. Chambers.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 3, p 296-304, December 1989. 4 fig, 8 tab, 12 ref.

Descriptors: *Aldicarb, *Ducks, *Insecticides, *Path of pollutants, *Poultry, *Water pollution effects, Eggs, Embryonic growth stage, Toxicity.

The duck eggshell has the reputation of being more permeable than that of the domestic hen. If this is true, the developing embryo could be at greater risk from xenobiotic agents, since toxicants picked up on the feathers could be transferred to the embryo during incubation. Such an effect was studied in developing duck embryos after the application of aldicarb to the eggshell. At 72 hr, the eggs were painted with 3, 7, 11 or 15 micromoles of aldicarb in 500 microliters of water. The eggs were then incubated to Day 24. The gross morphological measurements were recorded. A similar study was made using domestic hen eggs; these were treated after 36 hr incubation and incubated to Day 17. Direct injection into the yolk sac of both species was used for further comparison. There was a statistically significant reduction ($P < 0.01$) in the middle web toe length with 11 and 15 micromoles of aldicarb and the tarsometatarsus length with 7, 11, and 15 micromoles. Compared with the duck control group, the group given 15 micromoles of aldicarb had reductions of approximately 8% in the tarsometatarsus and approximately 9% in the middle web toe. No statistically significant changes were produced in the chick embryos. (Author's abstract)
W90-05944

ECOTOXICOLOGICAL CHARACTERIZATION OF INDUSTRIAL WASTEWATER: SULFITE PULP MILL WITH BLEACHING.
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W90-05945

DISTRIBUTION OF (C14)ACRYLAMIDE IN RAINBOW TROUT STUDIED BY WHOLE-BODY AUTORADIOGRAPHY.
Louisville Univ., KY. Dept. of Pharmacology and Toxicology.
W. J. Waddell, J. J. Lech, C. Marlowe, K. M. Kleinow, and M. A. Friedman.
Fundamental and Applied Toxicology FAATDF, Vol. 14, No. 1, p 84-87, January 1990. 3 fig, 10 ref.

Descriptors: *Acrylamide, *Autoradiography, *Bioaccumulation, *Fish physiology, *Path of pollutants, *Trout, Blood, Gills, Kidneys, Liver, Muscle, Pollutant identification.

The distribution of (2,3-C14)acrylamide was studied in fingerling rainbow trout by whole-body autoradiography. Fish weighing approximately 7 gm were injected intraperitoneally with 3.2 milligrams/kilograms (C14)acrylamide. One group of fish was kept in a fresh flowing water tank and frozen in dry ice/hexane 22 hr after injection; another group was placed in a separate tank of fresh flowing water and frozen 120 hr after treatment. A third group of fish served as nontreated controls. The autoradiographs of the fish at 22 hr showed the highest concentration of radioactivity in the kidney, urinary bladder, blood, gall bladder, intestinal contents, and eye lens. Lesser amounts of radioactivity were seen in the central nervous system, liver, and gills. Very low concentrations were found in muscle, the tissue usually consumed by man. By 120 hr the only high concentrations were in gall bladder and eye lens. Lesser amounts were found in the sclera, vertebrae, central nervous system, kidney, wall of intestine, and discrete spots in subcutaneous tissue presumed to be chromatophores. (Author's abstract)
W90-05948

TWO-DIMENSIONAL MIXING IN RIVERS WITH UNSTEADY POLLUTANT SOURCE.
Ryerson Polytechnical Inst., Toronto (Ontario). Dept. of Civil Engineering.
G. K. Y. Luk, Y. L. Lau, and W. E. Watt.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 125-143, January/February 1990. 11 fig, 3 tab, 37 ref.

Descriptors: *Mathematical models, *Mixing, *Natural streams, *Path of pollutants, Advection, Dispersion, Model studies, Numerical analysis, Steady flow, Tracers.

A numerical model, the mixing analysis based on the Concept of Stream Tubes, has been developed for the analysis of two-dimensional, transient mixing of nonconservative substances in natural streams. The model can be applied to steady flows in sinuous, nonprismatic channels. A curvilinear coordinate system is used to account for variations in velocity, depth, and channel curvature. By dividing the stream tubes into variable length elements so that the Courant number for the grid space is always equal to unity, the problem of numerical diffusion and dispersion in the computation of streamwise advection is avoided. The model has been verified with analytical solutions for the cases of simple advection, continuous line source and instantaneous injection. Dispersion experiments were carried out in a sinuous channel with irregular bottom topography, using both slug injection and a variable rate injection of tracer. Measured time-concentration data agree quite well with predictions using the mixing analysis based on the Concept of Stream Tubes. (Author's abstract)
W90-05960

PREDICTING ORGANIC ACCUMULATION IN SEDIMENTS NEAR MARINE OUTFALLS.
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
For primary bibliographic entry see Field 5E.
W90-05961

EFFECTS OF PHENOL WASTEWATER CO-DISPOSAL ON THE ATTENUATION OF THE REFUSE LEACHATE MOLECULE HEXANOIC ACID.
University of Strathclyde, Glasgow (Scotland). Dept. of Bioscience and Biotechnology.
I. A. Watson-Craik, and E. Senior.
Letters in Applied Microbiology LAMIE7, Vol. 9, No. 6, p 227-232, December 1989. 4 fig, 11 ref.

Descriptors: *Ecological effects, *Fate of pollutants, *Landfills, *Leachates, *Model studies, *Path of pollutants, *Phenols, *Soil bacteria, Hazardous waste disposal, Methanogenesis, Sulfates, Wastewater disposal.

A three-stage continuous culture model system was used to investigate the impacts of increasing concentrations of phenol on the component physiological groups of a hexanoate-catabolizing association, isolated from anoxic landfill. After inoculation, and prior to supplementation of the experimental system with incremental concentrations of phenol, the models were monitored to characterize the hexanoate-catabolizing association. Throughout the investigation, phenol analyses indicated that there was no significant dissimilation of the molecule so that metabolic intermediates such as acetate, and products such as methane were assumed to have been derived from the degradation of hexanoic acid. Low concentrations (2 millimoles/L) were found to reduce sulfate-reducing bacterial activity while concentrations of 8 and 22 millimoles/L caused reductions of 90.2 and 99.1% in methane release rate and hexanoate beta-oxidation, respectively. Overall, the results of this study indicated that, in the presence of metabolically active phenolic methenogenic population, the co-disposal of wastewater with concentrations from 2 to 6 millimoles/L phenol had no inhibitory effect on the anaerobic catabolism of a representative leachate molecule, hexanoic acid. (Geiger-PTT)
W90-05964

INTERACTION OF ESTUARINE ORGANIC MATTER WITH COPPER AND BENZO(A)PYRENE.
Georgia Univ., Sapelo Island. Marine Inst.
J. J. Alberts, Z. Filip, and G. J. Leversee.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 77-87, December 1989. 1 fig, 3 tab, 33 ref. NSF Grant INT-8619167.

Descriptors: *Benzopyrene, *Copper, *Fulvic acids, *Humic acids, *Organic matter, *Path of pollutants, *Salt marshes, Adsorption, Estuaries, Marine sediments, Marsh plants, Organic carbon, Organic compounds, Salinity.

Fulvic and humic acids were isolated from living plants, dead plants and sediments of a salt marsh estuary in the southeastern United States. Total acidity (435-605 microequivalents H(+)/100 gm fulvic acid and 295-385 milliequivalents H(+)/100 gm humic acid), copper binding capacities (0.25-0.96 microequivalents Cu(++)/mg C fulvic acid and 0.46-0.65 microequivalents Cu(++)/mg C humic acid) and benzo(a)pyrene (BaP) partitioning coefficients (log10 K 3.48-3.86 and 4.12-4.29 for fulvic acids and humic acids, respectively) were determined and shown to be within reported ranges for fulvic and humic acids from other terrestrial and aquatic environments. Solubilities of fulvic acids, humic acids and BaP varied with salt concentration, with fulvic acid being least affected by increased salinity. Ultrafiltration of natural river waters from the region showed that BaP appears to be associated more with organic compounds of larger molecular size, and between-stream variation in composition of the dissolved organic carbon can significantly affect BaP binding to the organic carbon fractions of natural waters. (Author's abstract)
W90-05965

MERCURY DISTRIBUTION IN THE KRKA RIVER ESTUARY (EASTERN ADRIATIC COAST).
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
N. Mikac, Z. Kwokal, K. May, and M. Branica.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 109-126, December 1989. 6 fig, 4 tab, 41 ref.

Descriptors: *Adriatic Sea, *Estuaries, *Marine sediments, *Mercury, *Mussels, *Path of pollutants, *Water pollution sources, Bioaccumulation, Yugoslavia.

The distribution of total and organic mercury was studied in the water, sediments and mussels of the Krka River Estuary and the Kornati Archipelago (eastern Adriatic coast) during 1985-1987. The mercury content of the silt/clay sediment fraction was analyzed to reduce the influence of irregular sediment structure. The results obtained suggest that both the Krka River and the Kornati Archipelago are unpolluted by mercury. A slight increase in the mercury concentrations in the central part of the estuary points to the possibility of pollution by anthropogenic sources. The distribution of the concentration of reactive mercury (0.3-3.0 nanograms/cu dm) in the unfiltered water followed the distribution pattern obtained for sediment. The portion of reactive versus total mercury in water was considerably lower in the freshwater surface layer (30-50%) than in the deeper saline water layer (> 80%) of the stratified Krka River Estuary. Mercury accumulation was observed at the interface of these two layers (at the halocline). The concentrations of mercury in mussels (10-50 micrograms/kg wet wt) were significantly affected by internal biological factors and their distribution differed from the pattern observed for sediments and water. Despite the fact that organic mercury has been detected in sediments and the edible part of the mussels, it has not for a certainty been established in water. A tendency to consider the Mediterranean as an area of higher natural mercury levels has been challenged by the fact that the concentrations obtained are in the same range as those obtained for other unpolluted marine areas throughout the world. (Author's abstract)
W90-05967

STUDIES ON THE TRANSFER OF HEAVY METALS BETWEEN SEDIMENTARY PHASES WITH A MULTI-CHAMBER DEVICE: COMBINED EFFECTS OF SALINITY AND REDOX VARIATION.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
U. Foerstner, W. Ahlf, and W. Calmano.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 145-158, December 1989. 7 fig, 27 ref.

Descriptors: *Algae, *Bioaccumulation, *Estuaries, *Heavy metals, *Marine sediments, *Path of pollutants, Cadmium, Copper, Dredging, Ecological effects, Environmental effects, Hydrogen ion

concentration, Iron, Organic matter, Oxidation-reduction potential, Salinity, Zinc.

Mobilization and transfer of heavy metals to major sediment components after changes of typical estuarine conditions (salinity, redox potential/pH) have been studied in a newly developed experimental device, consisting of a central chamber connected with six external chambers and separated by membranes of 0.45-microns pore diameter. Algal cell walls (Scenedesmus quadricuada), bentonite, aluminum oxide, manganese oxide, quartz powder and goethite were used as model sediment components. Significant metal enrichment was found on algal cell walls, and on freshly precipitated iron hydroxide. Oxidation of anoxic mud from Hamburg harbor causes lowering of pH and remobilization of cadmium and zinc. The experiments on the effect of seawater on sediment components and dredged mud indicate the dominant role of organic substrates in the binding of metals such as cadmium and copper, suggesting that even at relatively small percentages of organic substrates these materials are primarily involved in metabolic processes and thus may constitute the major carriers by which metals are transferred within the food chain. These results demonstrate that it is particularly problematic to disperse waste materials in ecologically productive, high-energy environments such as estuaries. (Author's abstract)
W90-05968

RIVER VERSUS ATMOSPHERIC INPUT OF MATERIAL TO THE MEDITERRANEAN SEA: AN OVERVIEW.
Institut de Biogeochimie Marine, Montrouge (France).
J.-M. Martin, F. Elbaz-Poulichet, C. Guieu, M.-D. Loye-Pilot, and G. Hans.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 159-182, December 1989. 4 fig, 11 tab, 61 ref.

Descriptors: *Air pollution, *Mediterranean Sea, *Nitrogen, *Path of pollutants, *Radioisotopes, *Trace metals, *Water pollution sources, Cadmium, Cesium radioisotopes, Copper, Lead, Nitrates, Plutonium radioisotopes, Rivers.

The Land-Sea Interactions Group of CNRS (1984-1987) and the EROS-2000 program (1987-1988) studied river and atmospheric fluxes on a variety of elements and compounds in the Mediterranean Sea which is close to potential pollution sources in Northern Europe and subjected to the influx of Sahara red dust. Representative rivers emptying into the Mediterranean Sea were sampled for nutrients, radionuclides and metals while atmospheric fallout data was collected at monitoring stations in southern France. Results show that the atmospheric input of red dust is of the same order of magnitude as the annual downstream flow of rivers discharging to the Western Mediterranean. The atmospheric flux of Cu, Pb and Cd exceeded river input by one to two orders of magnitude. However, the incoming flux through the straits of Sicily and mainly Gibraltar might be as important as the atmospheric flux; the residence times of these three metals are either shorter than the water renewal time (Pb, Cu) or equivalent to it, so that their accumulation in the water column is unlikely. Atmospheric input was predominant for Pu(239+240) and Cs(137), whereas Pu(238) is mainly of riverine origin. The fluxes of nitrogen supplied by rivers and rain were approximately equivalent. It was estimated that the atmospheric nitrogen corresponds to 10% of the average new production and may reach values as high as 50% during oligotrophic periods. (Geiger-PTT)
W90-05969

CADMIUM-INDUCED PROTEINS FROM MYTILUS GALLOPROVINCIALIS: POLAROGRAPHIC CHARACTERIZATION AND STUDY OF THEIR INTERACTION WITH CADMIUM.
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
For primary bibliographic entry see Field 5C.
W90-05970

CONSERVATIVE MIXING IN ESTUARIES AS AFFECTED BY SORPTION, COMPLEXING AND TURBIDITY MAXIMUM: A SIMPLE MODEL EXAMPLE.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 2L.
W90-05971

AQUEOUS OZONATION OF PESTICIDES: A REVIEW.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-05972

KEJIMKUJIK PARK--ONE IN A FAMILY OF INTEGRATED WATERSHED STUDIES.
Atmospheric Environment Service, Downsview (Ontario). Long-Range Transport of Airborne Pollutants Program.
F. C. Elder, and H. C. Martin.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 1-12, July/August 1989. 8 fig, 1 tab, 15 ref.

Descriptors: *Acid rain, *Acidic water, *Canada, *Lakes, *Organic matter, *Path of pollutants, Acidity, Air pollution, Comparison studies, Environmental effects, Kejimkujik National Park, Nova Scotia, Water pollution.

The Canadian federal research program related to the Long-Range Transport of Airborne Pollutants included integrated studies to be carried out in selected watersheds. These watersheds were selected through consideration of the then existing studies as well as the need to provide information on the range of ecosystems susceptible to acidification in Canada. The biogeochemical characteristics, demonstrating atmospheric deposition loading, the study area sensitivity to acidification, and the reaction or evidence of effects of the site selected in the highly sensitive region of Nova Scotia, the Kejimkujik National Park, are presented in comparison with nine other integrated study sites in North America and in Europe. It is shown that the Kejimkujik site represents a system that is dominated by very dilute but highly organic waters not found in other study sites. (Mertz-PTT)
W90-05977

PRECIPITATION CHEMISTRY IN NOVA SCOTIA: 1978-1987.
Nova Scotia Dept. of the Environment, Halifax.
J. K. Underwood, J. G. Ogden, and D. H. Waller.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 13-27, July/August 1989. 7 fig, 3 tab, 15 ref.

Descriptors: *Acid rain, *Acidic water, *Air pollution, *Canada, *Chemistry of precipitation, *Precipitation, Hydrogen ion concentration, Lakes, Nitrates, Nova Scotia, Path of pollutants, Sulfates, Water pollution.

More than 1400 precipitation samples were collected weekly from five sites in Nova Scotia between 1978 and 1987. High concentrations of H(+), nonmarine SO4(-2) and NO3(-) were observed in 1978 and 1986. In 1983, concentrations of all three parameters were the lowest in the data record. Fluctuations in emissions for SO2 are insufficient to account for the variability observed in concentration and deposition values. Mean annual concentrations in 1983 were 13 microequivalents/L for H(+), 16 microequivalents/L for SO4(-2), and 6 microequivalents/L for NO3(-). In 1986, the values were 35, 28, and 13 microequivalents/L. Concentrations in 1978 were 31, 38, and 16 microequivalents/L. Average pH of precipitation was 4.61 during the 10 year study. The two most acidic years were 1979 (4.47) and 1986 (4.46). In 1983, the average pH was 4.89. The ratio (equivalents) of NO3(-) to SO4(-2) was 0.41, so most acidity in the precipitation results from H2SO4. However, multiple regression analysis revealed the H(+) is more sensitive to changes in NO3(-) concentrations than SO4(-2). Ratios of summer vs. winter average concentrations were examined. During summer months, SO4(-2) and H(+) were 1.8 times winter values. The summer to winter ratio for NO3(-) was 1.4 and for NH4(+) was 2.5. (Author's abstract)
W90-05978

ESTIMATION OF ATMOSPHERIC DEPOSITION INPUT OF SULPHUR AND NITROGEN OXIDES TO THE KEJIMKUJIK WATERSHED: 1979-1987.
Atmospheric Environment Service, Downsview (Ontario).
A. Sirois, and P. W. Summers.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 29-43, July/August 1989. 6 fig, 4 tab, 14 ref.

Descriptors: *Acid rain, *Canada, *Chemistry of precipitation, *Ions, *Nitrogen, *Sulfates, Acidity, Air pollution, Deposition, Kejimkujik National Park, Nova Scotia, Seasonal variation.

Daily measurements of the concentrations of major ions in ambient air and in precipitation at Kejimkujik National Park, Nova Scotia, Canada over the period May 1979 to December 1987 are used to estimate the wet, dry and total deposition to the watershed. Variations on three time-scales are apparent. The strongest variation, of up to two orders of magnitude occurs on a day to day basis resulting in a coefficient of variation in the range of 110 to 140%. Deposition is highly episodic with the highest 20% of the daily events accounting for 55 to 60% of the long-term deposition. The most systematic variation is the annual cycle observed for many of the species. The air concentration of SO2 has the most pronounced cycle with a winter maximum and a summer minimum. The SO4(-2) air concentrations show a smaller amplitude and are out-of-phase with SO2, showing a summer maximum. Air concentrations of HNO3 and particulate NO3(-) also have an out-of-phase annual cycle, with a summer maximum for HNO3 and a summer minimum for NO3(-). Wet deposition of SO4(-2) shows a broad maximum through the summer months, but for NO3(-) no systematic cycle is evident. On an ion equivalent basis, NO3(-) contributes as much as SO4(-2) to the acidity of winter precipitation, but only one-third as much in the summer months. Although 8.7 years is too short a time-scale to establish long term variations with any certainty, there does appear to be an overall downward trend in S concentrations and deposition, but not for N. This is not inconsistent with the trends in the emissions of SO2 and NOx in the regions upwind of Nova Scotia. The fraction of the S input to the watershed as dry deposition is estimated to average 22% of the total. (Author's abstract)
W90-05979

METEOROLOGICAL CHARACTERISTICS OF LARGE ACIDIC DEPOSITION EVENTS AT KEJIMKUJIK, NOVA SCOTIA.
Atmospheric Environment Service, Bedford (Nova Scotia).
For primary bibliographic entry see Field 2B.
W90-05980

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THREE ACIDIC, OLIGOTROPHIC LAKES AND THEIR WATERSHEDS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
J. Keredes, B. Freedman, S. Beauchamp, and R. Tordon.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 99-117, July/August 1989. 8 tab, 66 ref.

Descriptors: *Acid rain, *Acidic water, *Canada, *Chemistry of precipitation, *Oligotrophic lakes, *Physical properties, Acid lakes, Ammonium, Bogs, Calcium, Chemical properties, Chlorine, Deposition, Hydrogen ion concentration, Magnesium, Nova Scotia, Organic matter, Sodium, Sulfates.

Southwestern Nova Scotia receives acidic precipitation (average pH 4.5 to 4.6), and there are many water bodies that are susceptible to acidification.

This study characterized the physical and chemical features of three remote, oligotrophic lakes and their watersheds in this region, in order to provide baseline information against which assessments can be made of changes caused by atmospheric depositions. Two of the lakes are small (< 0.5 square km) and on headwater watersheds: Beaverskin Lake has an almost completely forested watershed and is moderately acidic and clear (pH 5.3, 5 Hazen units), while the watershed of Pebbleloggitch Lake is about 2/3 forested and 1/3 covered by a Sphagnum-heath bog, and its water is very acidic and highly colored (pH 4.3, 87 Hazen units). Kejimkujik Lake is much larger, its watershed is mostly forested but also contains some boggy terrain, its water is intermediate in acidity and color (pH 4.9, 65 Hazen units), and because it drains a much larger area of watershed it has relatively large concentrations of Ca, Mg, Na, Cl, and SO4. The most prominent cations in precipitation were H(+) (accounting for 41.5% of total cation equivalents), Na (36.5%), Mg (7.9%):, NH4(+) (7.2%), Ca (5.4%) and K (1.5%). The most prominent anions were Cl (44.4%), SO4(43.5%) and NO3 (12.1%). Average concentration of particulate SO4 (-2) was 2.1 microgram/cubic meter and for SO2, 1.5 microgram/cubic meter. About 71% of the total S deposition of 7.2 kg/ha/yr occurred as wet deposition of SO4, while 26% was dry deposition of SO2, and 3% was dry deposition of SO4. During 1968 to 1982 annual precipitation averaged 1458 mm/yr, of which 18% arrived as snow. On average, total precipitation was greater during October to March, compared with April to September. (Mertz-PTT)
W90-05981

SOURCES OF ACIDITY IN FOREST-FLOOR PERCOLATE FROM A MAPLE-BIRCH ECOSYSTEM.
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
P. W. Hazlett, and N. W. Foster.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 87-97, July/August 1989. 5 fig, 4 tab, 19 ref.

Descriptors: *Acid rain, *Acidic water, *Canada, *Forest soils, *Forest watersheds, *Hydrogen ion concentration, *Soil water, Acidity, Anions, Calcium, Cations, Deciduous forests, Nitrates, Ontario, Organic matter, Percolation, Seasonal variation, Sulfates.

Ion concentrations in water collected within a forest of sugar maple and yellow birch at the Turkey Lakes Watershed near Sault Ste. Maria, Ontario were examined from 1982 to 1984 to determine sources of acidity and the extent of cation leaching from forest-floor horizons. Volume-weighted concentrations and ion fluxes in throughfall and forest-floor percolate during the growing and dormant seasons were calculated. Hydrogen ion content of the forest-floor percolate decreased in relation to that of throughfall in the dormant season and increased in the growing season. Hydrogen ion deposition in throughfall could account for 100% of the flux of H(+) through the forest floor in the dormant period, and 40% of the flux during the growing season. In forest-floor percolate, Ca(+2) concentrations were positively correlated with those of SO4(-2), NO3(-) and organic anions during both dormant and growing seasons. Sources of NO3(-) and organic anions within the ecosystem and major external inputs of NO3(-) and SO4(-2) were critical factors that influenced cation mobility in the forest floor. (Author's abstract)
W90-05982

IMPACTS OF FORESTS ON WATER CHEMISTRY.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
For primary bibliographic entry see Field 2K.
W90-05983

VEGETATION, SOILS, AND ION TRANSFER THROUGH THE FOREST CANOPY IN TWO NOVA SCOTIA LAKE BASINS.
Maritimes Forest Research Centre, Fredericton (New Brunswick).
For primary bibliographic entry see Field 2K.
W90-05984

PATTERNS OF WATER CHEMISTRY AMONG TWENTY-SEVEN OLIGOTROPHIC LAKES IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-05985

SEASONAL VARIATIONS OF WATER CHEMISTRY IN OLIGOTROPHIC STREAMS AND RIVERS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 2K.
W90-05986

ALUMINUM SPECIES IN POREWATERS OF KEJIMKUJIK AND MOUNTAIN LAKES, NOVA SCOTIA.
National Water Research Inst., Burlington (Ontario).
H. K. T. Wong, J. O. Nriagu, and K. J. McCabe.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 155-164, July/August 1989. 3 fig, 1 tab, 19 ref.

Descriptors: *Acid rain, *Canada, *Interstitial water, *Lake sediments, *Lakes, Aluminum, Chemical properties, Hydrogen ion concentration, Kejimkujik National Forest, Membrane filters, Nova Scotia, Organic carbon, Sediments.

Sediment porewaters were recovered by the membrane dialysis technique from Kejimkujik Lake and Mountain Lake in Nova Scotia and analyzed for pH, dissolved organic carbon, total (acid soluble) aluminum, total reactive monomeric aluminum, organic monomeric aluminum and inorganic monomeric aluminum. The results show that in the colored lake water (Kejimkujik), close to 100% of the total reactive monomeric aluminum fraction is bound to organic matter and that 10 to 60% of the total aluminum is in the monomeric form. In the clearwater lake (Mountain), 50 to 65% of total reactive monomeric aluminum fraction is associated with organic matter and less than 4 to 5% of the total aluminum is in the monomeric form. The concentrations of reactive monomeric species in organic-rich porewaters decrease with time of storage due to the precipitation of organo-Al compounds. Model calculations using the porewater profiles of Al suggest that the sediment can be an important source of dissolved Al to the overlying water. (Author's abstract)
W90-05988

CHEMICAL CHARACTERIZATION OF SEVERAL WETLANDS IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Canadian Wildlife Service, Hull (Quebec). Sustainable Development Branch.
For primary bibliographic entry see Field 2H.
W90-05990

FINNISH LAKE SURVEY: THE ROLE OF ORGANIC AND ANTHROPOGENIC ACIDITY.
National Board of Waters, Helsinki (Finland). Water Research Inst.
P. Kortelainen, J. Mannio, M. Forsius, J. Kamari, and M. Verta.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 235-249, July/August 1989. 5 fig, 2 tab, 33 ref.

Descriptors: *Acid lakes, *Acid rain, *Finland, *Humic acids, *Hydrogen ion concentration, *Lakes, *Organic carbon, *Organic matter, *Surveys, *Water chemistry, Acidic water, Acidity, Anions, Peat soils, Precipitation, Sulfates.

A lake survey consisting of 987 randomly selected lakes was conducted in Finland in autumn 1987. The survey covered the whole country, and the water quality of the lakes can be considered as representative of the approximately 56,000 lakes larger than 0.01 square km in Finland. The median total organic carbon concentrations was 12 mg/L and the median pH 6.3. The proportion of lakes with total organic carbon concentrations >= 5 mg/L in the whole country was 91%. Organic anion is the main anion in the full data set (median 89 microequivalents/L). The high organic matter concentrations in Finnish lakes were associated with catchment areas containing large proportions of peatlands and acid organic soils under coniferous forest. The survey demonstrated that organic matter strongly affects the acidity of lakes in Finland. The decreasing effects of organic matter on the pH values was demonstrated by both regression analysis and ion balances. At current deposition levels of SO4 the pH of humic lakes in Finland is determined to a greater extent by high total organic carbon concentrations than by SO4 in most areas. In lakes with pH values lower than 5.5 the average organic anion contribution is 56% and nonmarine sulfate contribution 39%. However, in the southern parts of the country, where the acidic deposition is highest, the minerogenic acidity commonly exceeds the catchment derived organic acidity. (Author's abstract)
W90-05996

RAIN PROJECT: ROLE OF ORGANIC ACIDS IN MODERATING PH CHANGE FOLLOWING REDUCTION IN ACID DEPOSITION.
Norsk Inst. for Vannforskning, Oslo.
R. F. Wright.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 251-259, July/August 1989. 4 fig, 2 tab, 10 ref.

Descriptors: *Acid rain, *Acid water, *Chemistry of precipitation, *Norway, *Soil chemistry, *Water chemistry, Acidity, Alkalinity, Anions, Cations, Chemical properties, Hydrogen ion concentration, Organic acids, Organic carbon, Runoff, Sulfates, Surveys.

The RAIN project (Reversing Acidification In Norway) entails catchment-scale experimental manipulations to investigate the effect on water and soil chemistry of drastic changes in precipitation chemistry. At Risdalsheia in southernmost Norway wet deposition of acid is excluded from a 860 square meter headwater catchment by means of a roof and clean precipitation is added beneath. Four years of acid exclusion (through June 1988) have resulted in lower concentrations of the strong acid anions NO3 (from 35 to 7 microequivalents/L) and SO4 (from 110 to 53 microequivalents/L) in runoff. The decline in strong acid anion concentrations has been compensated partially by a decrease in concentrations of base cations (55%) and partially by an increase in alkalinity (45%). pH has increased only slightly from 4.0 to 4.1. Organic acids have become increasingly important for the pH of runoff. Runoff from the shallow organic soils contains 10 to 20 mg C/L total organic carbon. The concentration of organic anions (estimated from the ionic balance) has increased from about 22 microequivalents/L in 1984 to 49 microequivalents organic acids and not to change in total organic carbon concentrations. The organic C in these acid samples apparently has a maximum charge density of about 4.5 microequivalents/mg C and pK of about 4. (Author's abstract)
W90-05997

APPLICATION OF HYDROLOGICAL MODEL TO ACIDIFIED WATERSHEDS: A STUDY ON MERSEY RIVER AND MOOSEPIT BROOK, NOVA SCOTIA.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
A. G. Bobba, and D. C. L. Lam.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 261-275, July/August 1989. 8 fig, 2 tab, 20 ref.

Descriptors: *Acid rain, *Acid streams, *Canada, *Forest watersheds, *Hydrologic models, *Model studies, *Runoff, Comparison studies, Nova Scotia,

Organic carbon, Rank order correlation, Rivers, Snowmelt, Snowpack, Statistical analysis, Streamflow, Streams, Sulfates.

A hydrological model has been applied to Mersey River and Moosepit Brook watersheds, Nova Scotia. Observed data was compared with simulated results. To quantify the model performance, three statistical methods were used: the rank order correlation; the mean relative error; and the coefficient of efficiency. The hydrological model has been applied successfully to the watersheds with reasonably good predictions of the runoff, water equivalent and sulfate in the snow pack and dissolved organic carbon. The calibrated model coefficients were fairly consistent with known geological and geomorphological characteristics at these watersheds. The relationship between the hydrology and dissolved organic carbon was demonstrated, particularly during snowmelt episodes and among the watersheds. Relationships between stream flow and dissolved organic carbon was also observed. In general, with the hydrological components verified by the flow data, the stage is now set for linking this hydrological model with hydrogeochemical models. (Mertz-PTT)
W90-05998

MODELING ORGANIC AND INORGANIC ACIDITY IN TWO NOVA SCOTIA RIVERS.
National Water Research Inst., Burlington (Ontario).
D. C. L. Lam, A. G. Bobba, R. A. Bourbonniere, G. D. Howell, and M. E. Thompson.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 277-287, July/August 1989. 4 fig, 2 tab, 16 ref.

Descriptors: *Acid rain, *Acidic streams, *Acidic water, *Canada, *Model studies, *Organic acids, *Watersheds, Anions, Chemical properties, Color, Comparison studies, Hydrogen ion concentration, Kinetics, Nova Scotia, Rivers, Sulfates.

A watershed acidification model was modified to include organic acids and applied to the colored Moose Pit Brook and Mersey River in Nova Scotia. Comparison with 1983-1985 data confirmed the capability of the model to explain the different levels of organic and inorganic acidity exhibited by the two rivers. During model calibration for both rivers, the charge density was set at about 4 microequivalents organic anion/mg C of dissolved organic carbon, as compared to a value of 10 previously reported. The difference was significant and could affect the predicted pH substantially. The three-component formulation can be extended to allow mixture of organic functional groups with different charge densities, each with different pKs. However, since no data were available on these constants as formulated for the two rivers, the advantage of using a triprotic or other organic acid formulation was not fully demonstrated. The computed results indicated that the organic anion model constants were as sensitive and hence equally as important as the sulfate input parameter in both watersheds. Thus, the model shows that the decrease or increase of sulfate inputs to these two colored streams does not cause as large a change in the mean pH as in clear water systems. This result confirmed the importance of the organic anions as buffering agents. (Mertz-PTT)
W90-05999

SPATIAL CHARACTERIZATION OF ACIDIFICATION RELATED PARAMETERS IN SENSITIVE REGIONS OF ATLANTIC CANADA.
National Water Research Inst., Burlington (Ontario).
S. R. Esterby, A. H. El-Shaarawi, G. D. Howell, and T. A. Clair.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 289-303, July/August 1989. 7 fig, 4 tab, 12 ref.

Descriptors: *Acid lakes, *Acid rain, *Acidic water, *Air pollution, *Canada, *Color, *Lakes, *Water pollution, Alkalinity, Calcium, Chemical properties, Chlorides, Cluster analysis, Component ordination., Conductivity, Daa analysis, Marine aerosols, Newfoundland, Nova Scotia, Surveys, Weathering.

Many lakes in eastern Canada are sensitive to long range transport of atmospheric pollutants because of their low buffering capacity. Thus, it is important to assess long-term changes in water quality. Due to the large number of lakes, a method was needed for choosing a subset of lakes to monitor regularly. Preliminary surveys were conducted in Nova Scotia and Newfoundland in which water quality parameters connected with acidification were measured in a set of lakes in each region. Lakes were divided into several groups, with lakes in a group having similar water quality parameter values, by means of cluster analysis and principal component ordination. The lakes from both provinces were divided into two large clusters in Nova Scotia and three large clusters in Newfoundland, with important differences between the parameters of the groups. A number of small clusters accounted for less common lake types. For both provinces, water color was an important variable in the determination of the membership of the large clusters. In Nova Scotia both large clusters had similar characteristics for alkalinity, Ca, chloride, and to a lesser extent, conductivity, the parameters related to terrestrial weathering and marine aerosol. For Newfoundland lakes, two large clusters displayed the difference in acidity related parameters together with similarity in weathering and marine related parameters, as found for Nova Scotia, and a third large cluster, characteristic of less susceptible lakes, had higher pH values and low color. (Mertz-PTT)
W90-06000

UPTAKE AND CATABOLISM OF TRIBUTYLTIN BY BLUE CRABS FED TBT CONTAMINATED PREY.
National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
For primary bibliographic entry see Field 5C.
W90-06020

SURVEY FOR PESTICIDES IN WELLS ASSOCIATED WITH APPLE AND PEACH ORCHARDS IN WEST VIRGINIA.
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.
H. W. Hogmire, J. E. Weaver, and J. L. Brooks.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 81-86, January 1990. 3 tab, 4 ref. Contract No. USDA-TPSU-WVU-2057-330.

Descriptors: *Agricultural chemicals, *Apples, *Groundwater pollution, *Nonpoint pollution sources, *Orchards, *Peaches, *Pesticides, *Wells, Chlorinated hydrocarbons, Endrin, Halogenated pesticides, Path of pollutants, Terbacil, Water sampling, West Virginia.

Commercial apple and peach orchards in the eastern panhandle of West Virginia typically receive 10 to 13 pesticide applications per year for the control of arthropod pests and diseases. Water used for spray application is obtained primarily from wells located at or near pesticide mixing sites within or adjacent to the orchards. Because of heavy pesticide usage in orchards and the nature of the soil structure in the eastern panhandle, this study was conducted during 1985 and 1986 to evaluate wells associated with orchards for pesticide contamination. Twenty wells associated with orchards were sampled including wells located within and adjacent to orchards, wells located at pesticide mixing sites and various distances from mixing sites, and wells with various use patterns (household, pesticide mixing, or both). All wells were sampled monthly from May to October during 1985; those 5 wells with detectable pesticide residues were sampled monthly from April to November in 1986. No pesticides were found in 15 of the 20 wells sampled. Five wells contained terbacil residues in 1985 (up to 1.2 ppb); however no terbacil was detected in 1986. Four of the five wells with terbacil residues also had residues of endrin (0.1 to 1.6 ppb). Endrin was commonly used from 1955 to the early 1970's as a single ground application per year for orchard vole control. Although endrin is no longer used, its detection in this study reveals the persistence and potential of this chlorinated hydrocarbon to contaminate groundwater years after use has ceased. (VerNooy-PTT)
W90-06035

FATE OF DIETARY CADMIUM AT TWO INTAKE LEVELS IN THE ODONATE NYMPH, AESHNA CANADENSIS.
Trent Univ., Peterborough (Ontario). Dept. of Biology.
P. A. Martin, D. C. Lasenby, and R. D. Evans.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 54-58, January 1990. 3 fig, 1 tab, 18 ref.

Descriptors: *Cadmium, *Dragonflies, *Path of pollutants, Animal tissues, Aquatic insects, Bioassay, Biological magnification, Food chains, Heavy metals, Insects, Tissue analysis, Water pollution effects.

While it is known that cadmium is concentrated from the water to the tissues of aquatic biota through respiration and surface adsorption, the role of food in the uptake of Cd is not well understood. Often the exact quantity and Cd concentration of the food consumed is unknown, with the food items being either sediment or a mixture of microplankton. In the present study, the flux of dietary Cd was monitored using the mass balance technique with the dragonfly nymph (Aeshna canadensis). Using a predatory test organism, enabled researchers to feed the animals discrete, quantifiable prey items of known metal concentration. Nymphs were first fed blackflies (Simulium sp.) having Cd levels typical of relatively unpolluted waters. In the second experiment, nymphs were fed blackflies containing 49 to 75 micrograms Cd/g dry weight. The Cd concentration of fecal pellets was significantly higher than that of the food source concentration ($p < 0.05$) in both experiments, resulting in metal enrichment factors of 7.95 and 5.3 for experiments 1 and 2, respectively. Mass balance calculations indicate that total Cd egested in experiment 1 was significantly greater than the total Cd ingested ($p < 0.02$). This excess Cd might be explained by the ability of the odonate fecal pellets to scavenge metal ions out of the water column. Nymphs fed the high Cd diet of experiment 2 had significantly higher Cd than those of experiment 1. Complete mass balances were calculated for each of five sacrificed nymphs. In 4/5 nymphs analyzed, the quantity of Cd egested or accumulated in the body was greater than the quantity ingested, resulting in an overall net increase in the metal. The consistency of the metal concentration, both between prey organisms and over time, should be ascertained to provide for an accurate assessment of the metal intake of the predator. (VerNooy-PTT)
W90-06036

RESIDUES OF 1-NAPHTHOL IN SOIL AND WATER SAMPLES IN AND AROUND BHOPAL, INDIA.
Industrial Toxicology Research Centre, Lucknow (India). Pesticide Toxicology Lab.
T. S. S. Dikshith, S. N. Kumar, R. B. Raizada, M. K. Shrivastava, and P. K. Kay.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 87-91, January 1990. 1 fig, 1 tab, 22 ref.

Descriptors: *Carbamate pesticides, *Carbaryl, *Degradation products, *India, *Pesticide residues, Alcohols, Chemical analysis, Gas liquid chromatography, Groundwater pollution, Path of pollutants, Soil contamination, Water pollution.

Carbaryl, a methyl carbamate insecticide, is known for its wide application and low mammalian toxicity. Carbaryl is an unstable compound and breaks down to 1-naphthol and to unidentified metabolites which are water soluble. The residues of 1-naphthol present in soil and water samples collected in and around Bhopal, India where carbaryl was commercially produced on large scale for more than a decade, were measured. Sixty two samples of soil, surface and ground waters (ponds, well and hand pumps) were obtained from different locations in and around Bhopal. Presence of 1-naphthol

was found in all the samples subjected to gas-liquid chromatography analysis. Water samples of wells had the minimal residual contents (0.012 ppm) and varied between 0.002 to 0.024 ppm. Samples from handpumps and ponds were 0.026 ppm (0.017 to 0.048 ppm) and ponds from 0.036 to 0.088 ppm, respectively. Soil samples obtained from ponds, however, showed alarming levels of 1-naphthol at 0.153 to 0.6565 ppm. More studies are in progress to quantitate the specific metabolite or all possible metabolites of carbaryl present in water and soil samples collected from Bhopal. (VerNooy-PTT)
W90-06038

OCCURRENCE AND SEASONAL VARIATION OF HEAVY METALS IN THE OYSTER SACCROSTREA IRIDESCENS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
F. Paez-Osuna, and C. Marmolejo-Rivas.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 129-134, January 1990. 4 fig, 2 tab, 12 ref.

Descriptors: *Bioaccumulation, *Heavy metals, *Oysters, *Path of pollutants, *Tissue analysis, Cadmium, Copper, Iron, Marine fisheries, Metals, Mexico, Nickel, Seasonal variation, Zinc.

The oyster Saccrostrea iridescens (naley, 1854) is a marine species of mollusc which is widely utilized for human consumption in Mexico, particularly along the Pacific coast. Oysters were collected monthly in the northwest coast of Mexico (Southern Gulf of California) between August 1985 and May 1986. Heavy metal concentrations in the organisms sampled by divers from a depth of 2 to 10 m were determined for total flesh (n=6); average concentrations were 3.6 micrograms/g for Cd, 20.4 for Cu, 93 for Fe, 9.4 for Mn, 1.7 for Ni, and 402 micrograms/g for Zn. Analyses were also run for chromium, cobalt, and lead. Both zinc and copper showed the highest concentration in October and the lowest in April (p = 0.01)). With exception of one month, the levels of cadmium and iron were relatively constant, while the cobalt, nickel and lead simultaneously showed a light enrichment in the months of autumn-winter, when the temperatures of seawater in the locality decrease from a range of 29 to 34 C, to 23 to 25 C. Results of this study are due, at least in part, to variation of the size (age) of the oyster depending on the season. Copper and zinc were positively correlated with size (p = 0.05 and p = 0.01), while chrome and manganese were negatively correlated (p = 0.01 for both). Samples having seasonally high size (as length) were found to have seasonally low concentrations of Cr and Mn and high concentrations of Cu and Zn. (VerNooy-PTT)
W90-06039

LIFE TABLE EVALUATION OF THE EFFECTS OF CADMIUM EXPOSURE ON THE FRESHWATER CLADOCERAN, MOINA MACROCOPA.
Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-06040

HEAVY METALS IN THE EASTERN OYSTER, CRASSOTREA VIRGINICA, OF THE MISSISSIPPI SOUND.
Gulf Coast Research Lab., Ocean Springs, MS. Analytical Chemistry Section.
T. F. Lytle, and J. S. Lytle.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 142-148, January 1990. 2 tab, 9 ref.

Descriptors: *Bioindicators, *Heavy metals, *Oysters, *Path of pollutants, *Water pollution, Animal tissues, Data interpretation, Estuarine environment, Mississippi Sound, Tissue analysis, Water quality.

Bivalves and other sessile estuarine organisms have been increasingly targeted as sentinels of ambient levels of heavy metals in the water column of coastal estuaries. As part of an extensive NOAA program sampling bivalves to monitor heavy metals along coastlines, Crassotrea virginica were collected in the Mississippi Sound. At each of five sites in January, 1988, 30 oysters were collected. Six from each site were analyzed for lead (Pb), cadmium (Cd), iron (Fe), copper (Cu), cobalt (Co), manganese (Mn), zinc (Zn), silver (Ag), nickel (Ni), mercury (Hg), aluminum (Al), chromium (Cr), molybdenum (Mo) and vanadium (V). Mean values of Pb, Fe, Co, Mn, Ni, Al, and Cr appear to be elevated in oysters at the seriously polluted Pascagoula River and Twin Island sites, compared to other sites. These areas also had the smallest oysters, and the largest oysters were from Graveline Bayou, which also had the lowest overall values of Cd, Fe, Cu, Mn, Zn and Al. Complications experienced when comparing this data to those from previous heavy metal studies are discussed. Problems addressed in this study but not resolved include size variations in organisms, geographical and genetic differences, individual variability in metal uptake ability, ingestion of sediment particles, and induction of metal binding proteins. (VerNooy-PTT)
W90-06041

ACCUMULATION OF AM-241 AND CM-244 FROM WATER AND SEDIMENTS BY HYALELLA SP. AND TUBIFEX SPP.
Washington Univ., Seattle. Lab. of Radiation Ecology.
T. H. Sibley, and J. S. Stohr.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 165-172, January 1990. 3 fig, 15 ref. US Public Health Service Grant RR-07096.

Descriptors: *Americium radioisotopes, *Amphipods, *Bioaccumulation, *Curium radioisotopes, *Laboratory methods, *Oligochaetes, *Radioactive wastes, Annelids, Crustaceans, Path of pollutants, Plutonium, Sediments, Tissue analysis, Water pollution effects.

Americium (Am) and Curium (Cm) isotopes are produced by nuclear reactions in commercial reactors and are major components of high level wastes. Am241 is also a decay product of plutonium-241 (Pu241). Both elements bind strongly to sediments which may be the principal source for uptake by benthic organisms in freshwater and marine environments. The bioaccumulation of Am and Cu by freshwater invertebrates was examined in laboratory experiments, using the amphipod Hyalella sp. and oligochaete Tubifex spp. Organisms were exposed to one of the isotopes from one of four sources (water, sand, detritus or NBS sediments) and samples were taken after 1 hour, 1 day, and 5 days of continual exposure. Measurable concentrations of Am241 were transferred to Hyalella from labeled water, sand and detritus, and accumulations from water occurred rapidly to produce concentrations in the organisms after 1 hour that were nearly 2 orders of magnitude higher than the soluble concentrations. Accumulation of Am241 by Tubifex was very similar to that by Hyalella. Soluble activity of Cm increased with time in both Hyalella and Tubifex experiments and exceeded the activity in the controls by nearly an order of magnitude after 5 days. Accumulation of Cm244 from labeled water by both organisms was very rapid. After 1 hour about 15% of the added Cm had accumulated in tubifex and 35% had accumulated in Hyalella. After 5 days, 75 to 85% of Cm244 was found in the organisms compared to about 35% of Am241. In the experiments with labeled particulates, measurable concentrations were never seen in organisms. (VerNooy-PTT)
W90-06043

INTERSTITIAL WATER CHEMISTRY OF PU239,240 AND AM241 IN THE SEDIMENTS OF THE NORTH-EAST IRISH SEA.
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Directorate of Fisheries Research.
S. J. Malcolm, P. J. Kershaw, M. B. Lovett, and B. R. Harvey.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 1, p 29-35, January 1990. 5 fig, 40 ref, append.

Descriptors: *Americium radioisotopes, *Fate of pollutants, *Interstitial water, *Irish Sea, *Marine sediments, *Path of pollutants, *Plutonium radioisotopes, *Radioactive wastes, *Water chemistry, Marine pollution, Metal complexes, Organic carbon, Particulate matter, Water pollution.

The distribution of Plutonium (Pu239,240) and Americium (Am241) derived from authorized discharges of the British Nuclear Fuels plc Sellafield reprocessing plant was studied in sediments and interstitial water of the north-east Irish Sea to examine the post-depositional behavior and to assess the potential for remobilization of the two radionuclides. The solid phase profiles of Pu239,240 and Am241 have major subsurface peaks which are not related to the distribution of organic carbon, iron, or manganese, but may reflect the history of discharge from Sellafield. The interstitial water profiles of reduced Pu and Am also show major subsurface peaks which are not related to the diagenetic processes or organic matter oxidation by oxygen or nitrate, nor to the remobilization of Fe and Mn. The interstitial waster radionuclide profiles show a qualitative relationship with the soil phase radionuclide profiles and this suggests an adsorption/desorption process described by apparent distribution coefficients in the range of 170,000 to 1,180,000 for reduced Pu and 350,000 to 890,000 for reduced Am. However, systematic variations of this measured apparent distribution coefficient with depth for Pu (and possibly Am) suggest that the sediment/interstitial water system is not at equilibrium. Available data do not support the suggestion that dissolved organic carbon is responsible for complexing Pu in the interstitial water. Scavenging of Pu and Am by precipitating oxide phases near the sediment surface is suggested. (Author's abstract)
W90-06056

INTERACTIONS BETWEEN ARSENIC AND IRON OXYHYDROXIDES IN LACUSTRINE SEDIMENTS.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
N. Belzile, and A. Tessier.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 1, p 103-109, January 1990. 2 fig, 2 tab, 51 ref.

Descriptors: *Arsenic, *Chemical interactions, *Iron oxides, *Lake sediments, *Path of pollutants, *Water chemistry, Adsorption, Dissolved solids, Interstitial water, Metal complexes, Particulate matter, Water pollution.

Arsenic and iron concentrations were measured in surficial sediments and in interstitial and overlying waters at 22 littoral stations at 16 lakes. The lakes were chosen to cover values of pH between 4.0 and 8.4 and various As concentrations. Depth-distributions of dissolved As and Fe concentrations suggest a close association of both elements in a dissolution-diffusion-precipitation cycle for Fe and adsorbed As. Using a simplified version of the surface complexation model, apparent adsorption constants of As onto natural Fe oxyhydroxides have been calculated from the concentrations of As and Fe determined in leachates of surficial lake sediments and the in situ measurement of dissolved As in their respective overlying wasters. These calculations assume, based on thermodynamic considerations and experimental evidence, that only As(V) is associated with the natural Fe oxyhydroxides. The binding intensity values obtained from these lakes are compared to those obtained for the adsorption of As(V) onto various synthetic iron oxyhydroxides in well-defined media. The binding constants derived from field measurements agree well with those obtained from laboratory experiments performed with amorphous Fe oxyhydroxides. (Author's abstract)
W90-06057

MICROBIAL OXIDATION OF CRUDE OIL HYDROCARBONS IN DANUBE WATER.
Slovenska Akademia Vied, Bratislava (Czechoslo-

vakia). Ustav Experimentalenj Biologie a Ekologie.
B. Trzilova, and L. Miklosovicova.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 84, No. 1, p 1-19, January 1990. 12 fig, 13 ref.

Descriptors: *Biodegradation, *Danube River, *Fate of pollutants, *Microbial degradation, *Oil pollution, *Water pollution treatment, Bacteria, Chromobacter, Flavobacterium, Hydrocarbons, Pseudomonas.

Bacterial degradation of soluble hydrocarbons in water of the Danube River was studied experimentally. Total organotrophic bacteria and bacteria of the genera Pseudomonas, Flavobacterium and Chromobacterium survived and grew in contaminated Danube water under static conditions and with aeration; this applied to hydrocarbon concentrations of up to 500 mg/L. Bacterial growth rate and the degradation rate of soluble hydrocarbons were both high during the first three days. Bacterial respiration was most intensive from the 3rd through 7th day of exposure, and depended on the composition of the bacterial microflora. (Lantz-PTT)
W90-06059

SPECIATION OF PHOSPHORUS IN THE ALTENWORTH-RESERVOIR OF THE RIVER DANUBE.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
For primary bibliographic entry see Field 2H.
W90-06060

EVALUATION OF THE SPECIATION OF INORGANIC CONSTITUENTS IN SEDIMENTS OF THE RESERVOIR AT ALTENWORTH OF THE RIVER DANUBE.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
M. Sager, R. Pucsko, and R. Belocky.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 84, No. 1, p 37-72, January 1990. 12 tab, 43 ref.

Descriptors: *Altenwoerth Reservoir, *Chemical speciation, *Metals, *Path of pollutants, *Pollutant identification, *Sediment contamination, Aluminum, Arsenic, Calcium, Chromium, Copper, Danube River, Heavy metals, Iron, Lead, Magnesium, Manganese, Nickel, Particle size, Phosphorus, Potassium, Zinc.

For the evaluation of the chemical speciation of major and trace elements in fine sediments of the Danube River, two independent consecutive leaching techniques were applied. The elements Al, As, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Ni, P, Pb, and Zn have been investigated in the grain size fractions> 20 microns, 20-60 microns, 60-200 microns, and unsieved, 6 times within a year at three sampling sites in the Altenwoerth Reservoir. Location and season seem insignificant, grain size effects are dominating. Correlation of the data from the unsieved samples with the mean diameter, shows that all total decomposition data are grain size dependent, indicating dilution by quartz. In the leaching procedures, the bulk fractions can be found, which are purely geogenic, while the surface-bound amounts could have passed into the sediments via the solution. For comparison, results from data of the literature, obtained with similar procedures, are briefly reviewed. In the samples from the Danube, Cr, CU, Co and Ni are rather immobile and geogenic. The anthropogenic load of Pb and Zn, already detectable by total decomposition and clay minerals. Concerning Fe, two amorphous phases could be distinguished by sequence I; the oxalate extractable surface layer contains many trace elements. Some P could be attributed to bulky geogenic apatite. Desorption sites and possible uncertainties of the applied procedures are discussed by cross correlations between the different leached amounts and by intercorrelations between the two sequences. Leaching with ethanol failed to yield organically bound amounts. Leaching with neutral ammonium chloride yields less 'exchangeable' Ca, Mg, Mn, P, Pb, and Zn than with ammonium acetate. The correlations of leached fractions with dissolved components in the interstitial water as well as with the composition of main minerals are poor, the latter showing the dominant role of noncrystalline solids in environmental behavior. (Lantz-PTT)
W90-06061

STUDY OF THE PRIMARY PRODUCTIVITY IN THE SHATT AL-ARAB ESTUARY AT BASRAH, IRAQ.
Basrah Univ. (Iraq). Dept. of Biology.
R. A. M. Hadi, A. H. A. Al-Mousawi, and A. J. M. Al-Zubaidy.
Journal of Biological Science Research (Baghdad) JBSREF, Vol. 20, No. 3, p 593-606, September 1989. 4 fig, 1 tab, 32 ref.

Descriptors: *Primary productivity, *Shatt Al-Arab River, *Water pollution effects, *Water pollution sources, Ammonia, Basrah, Chlorophyll a, Industrial wastewater, Iraq, Municipal wastewater, Nutrients, Organic carbon, Phosphates, Silicon.

Primary productivity was measured in the Shatt Al-Arab estuary and five of its main canals around the center of City of Basrah. The primary productivity of the estuary and two of its eastern canals was rather low, ranging from 18.5 to 52.9 cu mg C/h. The primary productivity in three of its western canals (major sewage-discharging canals) was very high and ranged from 31.5 to 3180.9 cu mg C/h. Chlorophyll-a analysis at the same stations showed a similar trend. These variations were documented with ammonia nitrogen, phosphate phosphorus, and silicon dioxide silicon results. These results indicate that sewage and industrial wastes of Basrah cause an increase in nutrient content, and probably the primary productivity, of the western canals. In Shatt Al-Arab however, the effect was less prominant. Agricultural runoff at this time seems to have little effect on the primary productivity in the eastern canals. (Lantz-PTT)
W90-06065

OCCURRENCE OF THERMOPHILIC CAMPYLOBACTERS IN RURAL AND URBAN SURFACE WATERS IN CENTRAL FINLAND.
National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology.
P. J. Martikainen, L. K. Korhonen, and T. U. Kosunen.
Water Research WATRAG, Vol. 24, No. 1, p 91-96, January 1990. 1 fig, 6 tab, 34 ref.

Descriptors: *Campylobacter, *Finland, *Microbiological studies, *Pathogenic bacteria, *Pollutant identification, *Surface water, Fecal coliforms, Filtration, Rural areas, Seasonal variation, Urban areas.

In order to clarify the occurrence of campylobacters, surface waters in rural and urban sites in Central Finland were studied in 1987-1988 using membrane filtration and enrichment techniques. The maximum isolation frequency was in autumn (24% of the sites were positive), with second peaks in spring (17-21% campylobacter-positive sites), and minima in summer and winter (5-6% of the sites were positive). The chemical and bacteriological parameters indicated higher fecal contamination in the campylobacter-positive than in the campylobacter-negative waters. Although the urban sites, based on the campylobacter-positive than in the campylobacter-negative waters. Although the urban sites, based on the enumeration of fecal indicator bacteria, were as contaminated as the rural sites, the isolation frequency of campylobacters in the urban waters was lower than in the rural ones. The results showed that when prefiltration is necessary in turbid waters, the membranes of 5.0 and 1/2 micron pore size had also to be cultured to avoid underestimation. Of the isolated strains 61 were biotyped as Campylobacter jejuni and one as C. coli. Of the C. jejuni strains, 64% were biotype 1 when the Skirrow and Benjamin hydrogen sulfide test was applied. Few of the isolated Penner serotypes and serogroup complexes are reported to be common in surface waters of England or U.S.A. Among the isolates there were serotypes common in human infections. (Author's abstract)
W90-06077

EFFECT OF SNOW AND SOIL FROST MELTING ON THE CONCENTRATIONS OF SUSPENDED SOLIDS AND PHOSPHORUS IN TWO RURAL WATERSHEDS IN WESTERN FINLAND.
National Board of Waters, Helsinki (Finland). Water Research Inst.
S. Rekolainen.
Aquatic Sciences AQSCEA, Vol. 51, No. 3, p 211-223, 1989. 6 fig, 1 tab, 35 ref.

Descriptors: *Finland, *Nonpoint pollution sources, *Phosphorus, *Runoff, *Snowmelt, *Suspended solids, *Water pollution sources, Agricultural watersheds, Cold regions, Frozen ground, Nutrients.

Hydrological processes are known to have a considerable effect on nutrient transport from agricultural land to watercourses. In cold temperature regions peak discharges are caused not only by storm conditions but also by melting of snow and frost. The objective of this work was to investigate the effects of snow and frost melt on concentrations of phosphorus and suspended solids. The samples were taken using flow-weighted automatic sampling techniques from two agricultural drainage basins. During the beginning of the snowmelt period the concentration of suspended solids was rather low by comparison with the total phosphorus concentration and the discharge. The different behavior compared with the relationships found during storm conditions was probably caused by continuous extraction of the soil surface by low ionic concentration melt water, and to some extent by leaching from plant residues. The gradual decrease of total phosphorus concentration during the frost thawing period could be attributed to the gradually increasing proportion of the subsurface and groundwater discharge in the runoff. (Author's abstract)
W90-06086

LOCALLY GENERATED ATMOSPHERIC TRACE METAL POLLUTION IN CANADIAN ARCTIC AS REFLECTED BY CHEMISTRY OF SNOWPACK SAMPLES FROM THE MACKENZIE DELTA REGION.
Arctic Labs. Ltd., Sidney (British Columbia).
K. Gorzelska.
Atmospheric Environment ATENBP, Vol. 23, No. 12, p 2729-2737, 1989. 1 fig, 8 tab, 49 ref.

Descriptors: *Arctic, *Chemistry of precipitation, *Path of pollutants, *Snowpack, *Trace metals, Mass balance, Spatial distribution.

Snowpack samples from 18 sites located in the vicinity of the MacKenzie delta town of Inuvik (68 degrees 22 minutes N, 133 degrees 42 minutes W) were collected in the winter of 1985-1986 and analyzed for trace metals (Pb, Zn, Ni, Cu, Cd) and particulate material load. The results of the analyses, combined with data pertaining to the local emissions, were used to determine major sources of trace metal pollution, its magnitude and spatial distribution. High concentrations of trace metals and particulate material were detected in samples collected in close proximity to emission sources (power plant, automobile emissions, refuse incineration). Out of town, the concentrations rapidly decreased with distance and approached order of concentration typical for remote northern regions at about 20 km from Inuvik. In all the samples, the trace metals were enriched with respect to crustal material. The level of enrichment was exceptionally high in samples collected in the town, which greatly exceeded the levels reported for other northern regions. Mass balance calculations have shown that most of the trace metals emitted by the local sources are transported outside the immediate vicinity of Inuvik. (Author's abstract)
W90-06098

PRINCIPAL COMPONENT ANALYSIS OF SO4(2-) PRECIPITATION CONCENTRATIONS OVER THE EASTERN UNITED STATES.

Environmental Protection Agency, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.
B. K. Eder.
Atmospheric Environment ATENBP, Vol. 23, No. 12, p 2739-2750, 1989. 5 fig, 3 tab, 24 ref.

Descriptors: *Acid rain, *Chemistry of precipitation, *Path of pollutants, *Principal component analysis, *Statistics, *Sulfates, Eastern United States, Spatial variability, Statistical analysis, Temporal variability.

The spatial and temporal variability of sulfate ion concentrations in precipitation over the eastern U.S. during the period 1981-1986 was examined through the use of principal component analysis. Application of Kaiser's Varimax orthogonal rotation led to the delineation of seven contiguous subregions, each displaying statistically unique sulfate ion concentration characteristics. These seven statistically significant modes of variability, which together accounted for 74.2% of the total variance, corresponded well with major sulfur oxide emission patterns. Examination of the time series associated with each subregion revealed a general seasonality in which periods of high concentrations are more likely during the summer, while periods of low concentration are more likely during the winter. This seasonal cycle, however, was more prevalent in those subregions which contained few major emissions, and was less prevalent and often obscured by perturbations in those subregions which contained major emissions. (Author's abstract)
W90-06099

TRACE METAL AND MAJOR ION COMPOSITION OF PRECIPITATION AT A NORTH SEA COASTAL SITE.

Marine Lab., Aberdeen (Scotland).
P. W. Balls.
Atmospheric Environment ATENBP, Vol. 23, No. 12, p 2751-2759, 1989. 4 fig, 4 tab, 35 ref.

Descriptors: *Acid rain, *Chemistry of precipitation, *Path of pollutants, *Sulfates, *Trace metals, Cadmium, Copper, Deposition, Fog, Iron, Lead, Manganese, Mist, North Sea, Zinc.

Major ion and trace metal (Zn, Cu, Cd, Pb, Fe, Mn) concentrations have been determined in 32 rainfall events at a North Sea coastal site over a period of 14 months (June 1987-July 1988). Precautions have been taken to avoid trace metal contamination. Trace metal depositions are positively correlated to excess sulfate deposition; the exception is Cd for which no clear relationship is evident. This is probably due to contamination of the samples with respect to Cd. The highest trace metal concentrations are associated with small rainfall events and with the occurrence of fog and mist, except for Cd and Zn which are lower. Therefore it is suggested that estimates of annual deposition be revised downwards. (Author's abstract)
W90-06100

RESOURCE DEVELOPMENT AND CONSERVATION HISTORY ALONG THE OHIO RIVER.

Ohio State Univ., Columbus. School of Natural Resources.
For primary bibliographic entry see Field 6G.
W90-06101

WATER QUALITY TRENDS OF THE UPPER OHIO RIVER FROM 1977 TO 1987.

Ohio State Univ., Columbus. School of Natural Resources.
T. M. Cavanaugh, and W. J. Mitsch.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 153-163, December 1989. 6 fig, 4 tab, 23 ref.

Descriptors: *Ohio River, *Water chemistry, *Water pollution control, Cyanide, Dissolved oxygen, Iron, Lead, Monitoring, Phenols, River flow, Suspended solids, Zinc.

Water quality trends from 1977 to 1987 at four stations in the upper Ohio River were explored statistically by use of the seasonal Kendall test for trends and informally described by comparison with flow data and water quality criteria. Monthly data for eight chemical parameters were evaluated: cyanide, phenolics, copper, iron, lead, zinc, dissolved oxygen, and total suspended solids. Results indicated general improvements in the water quality, most notably in decreasing concentrations of cyanide, phenolics, lead, and zinc. The strongest trends were noted for cyanide. Flow adjustment of the data did not affect conclusions about concentration trends, and flow-concentration regressions were weak. (Author's abstract)
W90-06102

DISSOLVED OXYGEN PROFILES AT MAJOR WASTEWATER DISCHARGES AND HYDROELECTRIC DAMS AND THE OHIO RIVER.

Kentucky Univ., Lexington. Dept. of Geology.
J. P. Wellner, and J. S. Dinger.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 164-171, December 1989. 3 fig, 12 tab, 7 ref.

Descriptors: *Aeration, *Dissolved oxygen, *Ohio River, *Wastewater treatment, Dissolved oxygen profiles, Hydroelectric plants, Temperature.

Dissolved oxygen (DO) concentrations in the summer of 1987 did not change significantly along the Ohio River between Wheeling, WV and Louisville, KY. Depth variation was evident but no temperature stratification was observed. DO concentrations downstream of hydroelectric dams decreased in each case. Degassing of the water passing through the turbines may have accounted for this decrease. No correlation was found between DO concentration and volume of effluent discharged from waste water treatment plants (WWTPs). Elevated DO concentrations existed at and below WWTPs, indicative of the general effectiveness of WWTP reaeration on DO concentrations at the point of discharge and approximately one mile down river. WWTPs in the highly urbanized Cincinnati area yielded results similar to the WWTPs as a whole, but a slight sag was evident at the Dry Creek WWTP. A hypothetical grab-sample taken at 1.5 m depth at mid-channel was compared to the mean obtained from a nine-sample-profile. The variation was not significant, indicating that grab-sampling would be equivalent to more detailed and expensive profile sampling under similar flow conditions in the river. (Author's abstract)
W90-06103

HEAVY METAL CONCENTRATIONS IN OHIO RIVER SEDIMENTS--LONGITUDINAL AND TEMPORAL PATTERNS.

Ohio State Environmental Protection Agency, Columbus.
J. D. Youger, and W. J. Mitsch.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 172-175, December 1989. 2 fig, 1 tab, 24 ref.

Descriptors: *Heavy metals, *Ohio River, *Path of pollutants, *Water pollution, Barium, Cadmium, Chromium, Copper, Distribution patterns, Iron, Lead, Manganese, Nickel, Temporal variation, Zinc.

Concentrations of barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc were determined in sediment samples collected in 1987 at 11 sites in the Ohio River between Pittsburgh, PA, and Louisville, KY. Samples were digested by nitric acid treatment. Concentrations of metals generally decreased with distance downstream, with highest values occurring in the industrial upper Ohio River. The longitudinal trend paralleled the pattern found 10 years earlier by the Ohio River Valley Water Sanitation Commission. Concentrations of cadmium, chromium, copper, iron, lead, nickel and zinc in 1987 were lower at most sites than those in 1977. In contrast, the manganese concentration was generally higher in 1987, while barium levels did not differ between the two sampling periods. Most metal concentrations in the Ohio River remain greater by two to eight standard deviations than background concentrations of metals published for the State of Ohio. (Author's abstract)
W90-06104

NON-VOLATILE CHEMICAL MUTAGENS IN SEDIMENTS OF THE KANAWHA RIVER, WEST VIRGINIA.

Marshall Univ., Huntington, WV. Dept. of Biological Sciences.
M. C. Waldron, and A. R. White.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 176-180, December 1989. 1 fig, 2 tab, 30 ref.

Descriptors: *Mutagens, *Sediment contamination, *Separation techniques, *Water pollution sources, *West Virginia, Bacteria, Chemical analysis, Pollutant identification.

Sediments from the Kanawha River Basin were examined for the presence of non-volatile chemical mutagens using the Salmonella/mammalian microsome assay. Surface sediments were collected at two sites, one upstream and the other downstream from the chemical manufacturing complexes at South Charleston, Institute, and Nitro, WV. Sediment samples were prepared for extraction by milling a portion of wet sediment with anhydrous sodium sulfate. Preliminary chemical fractionation was achieved by extracting milled samples sequentially with Freon-113, methylene chloride, acetone, and methanol. Bacterial mutagenicity tests were performed on each solvent fraction using Salmonella tester strains TA98 and TA100, with and without the addition of Aroclor-induced rat liver microsomal (S9) enzymes. Mutagens were recovered from both sampling sites and mutagenic responses were very similar in the two sediment samples. Both sites exhibited more TA98 than TA100 mutagenesis, indicating a greater abundance of frame-shift mutagens as compared to base-substitution type mutagens. The more polar sediment extracts (acetone and methanol) contained more mutagenic residues than did the less polar methylene chloride fractions. No mutagenic activity was recovered in the nonpolar Freon-113 extracts. Methanol extracts from the two sampling sites were different in that the downstream sample contained at least one direct-acting frame-shift mutagen, while the upstream sample was mutagenic only in the presence of S9 enzymes. (Author's abstract)
W90-06105

ENVIRONMENTAL CHARACTERISTICS OF AFFLUENTS OF THE DOBCZYCE RESERVOIR (SOUTHERN POLAND) IN THE PREIMPOUNDMENT PERIOD (1983-1985): 1. SOME PHYSICO-CHEMICAL INDICES.

Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
G. Mazurkiewicz.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 287-296, 1989. 1 fig, 6 tab, 13 ref.

Descriptors: *Eutrophication, *Limnology, *Poland, *Reservoirs, *Water pollution sources, *Water quality, Chemical properties, Dobczyce, Nutrient loadings, Physical properties.

The catchment basin of the future water supply reservoir at Dobczyce covers about 780 sq km and is composed of the basin of the River Raba, the largest affluent, and of the Brzezowka, Ratanica, Trzemesnia, Bulinka, Debnik, Zakliczanka, and Wolnica streams. On the basis of two-year physico-chemical studies carried out on the affluents of the Dobczyce Reservoir in the preimpoundment period, these feeders were characterized and the magnitude of annual loads of mineral nitrogen and phosphorus was determined. The magnitude of loading of mineral nitrogen (2.4 g cu m/year) and phosphorus (0.203 g cu m/year) qualifies the reservoir under construction as being of eutrophic type. (See also W90-06136 and W90-06137) (Author's abstract)
W90-06135

ENVIRONMENTAL CHEMISTRY OF HERBICIDES. VOLUME I.

CRC Press, Inc., Boca Raton, Florida. 207 p.
Edited by R. Grover.

Descriptors: *Herbicides, *Path of pollutants, *Pesticides, *Soil contamination, Adsorption, Model studies, Physicochemical properties, Soil water, Surface runoff, Volatilization.

Herbicides constitute the major portion of sales for all pesticides in the highly organized agricultural production systems in the western industrialized world. Over 100 million ha of agricultural land is now being treated with herbicides each year in the U.S. alone. The rapid increase in the use of herbicides over the past decade, and the continuing introduction of new herbicides, as well as the expanding research efforts at universities, government institutions, and in the agrochemical industry to improve 'efficacy' and 'safety', necessitate an ongoing review process which summarizes information, and highlights gaps in information in order to keep abreast of this rapidly expanding field. Due to the vast database being generated in this field, it was necessary to divide the subject matter in two volumes. Volume I deals with the physicochemical principles controlling the behavior of herbicides in the soil component of the environment, beginning with soil adsorption/desorption characteristics, diffusion and mass flow, and leading to transport as surface runoff and volatilization into the atmosphere. The last two chapters deal with the dissipation and transformations of herbicides in the soil. Each chapter deals with the physicochemical principles and processes controlling the behavior of herbicides, including a brief but critical account of the techniques associated with the subject matter at hand. This is followed by a summarizing of information for each herbicide class or group and tabulation of this information wherever possible. The type and role of models being developed as predictive tools, and validation using field data whenever feasible, also receive special attention. Finally, each chapter concludes with a summary, which indicates gaps in information and includes suggestions for potential areas of future research. (See W90-06165 thru W90-06168) (Lantz-PTT)
W90-06164

ADSORPTION AND BIOAVAILABILITY.
R. J. Hance.
IN: Environmental Chemistry of Herbicides. Volume I. CRC Press, Inc., Boca Raton, Florida. p 1-19, 85 ref.

Descriptors: *Adsorption, *Bioavailability, *Herbicides, *Path of pollutants, *Pesticides, Bioaccumulation, Chemical interactions, Soil chemistry, Vegetation.

The ability of soil to remove solutes from solution is so well established that for generations adventurers in arid regions have known it is possible to 'recycle' one's own urine for drinking by passing it through some sort of crude soil column. However, more precise studies have shown that the removal of solutes is not complete, but involves reversible processes which provide a wide range of ratios of distribution between the solid and liquid components. The equilibrium condition and the rate of its attainment are important factors affecting the biological availability of a chemical in the soil. The purpose of this chapter is to outline the important general features of the physical chemistry involved and to show how they, together with the constraints imposed by processes controlling uptake by living tissues, would be expected to affect the interactions of herbicides in the soil with living organisms. Mechanisms of adsorption discussed include: ionic bonds, ligand exchange, charge transfer, charge-dipole and dipole-dipole bonds, and Landon-Van der Waals forces. Adsorption, per se, is only one of several factors affecting the availability of herbicides in the soil to weeds and non-target organisms. Therefore, the situations in which adsorption seems to be the dominant influence and those in which it is not, are briefly reviewed. In the case of plants, it is important to remember that where availability is inferred from some measurement of whole plant response (e.g., dry weight), a number of environmental factors, such as availability of water, temperature, humidity, and light, may be involved, as well as factors. Therefore, response may not be a very good indicator of availability. (See also W90-06164) (Lantz-PTT)
W90-06165

MASS FLOW AND DISPERSION.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
P. S. C. Rao, R. E. Jessup, and J. M. Davidson.
IN: Environmental Chemistry of Herbicides. Volume I. CRC Press, Inc., Boca Raton, Florida. p 21-43, 2 fig, 1 tab, 115 ref.

Descriptors: *Convection, *Dispersion, *Groundwater pollution, *Herbicides, *Path of pollutants, *Soil water, Flow velocity, Heterogeneity, Interstitial water, Model studies.

Nonvolatile herbicides are transported in soil solution as a result of two physical processes: mass flow (or convection) and hydrodynamic dispersion. Convection is primarily responsible for the progressive leaching, and determines the position of the herbicide pulse(s). Dispersion results in a broadening of the pulse(s) about the peak. At the laboratory column scale, at least three processes contribute to dispersion: molecular diffusion within a pore, mixing due to pore-velocity distribution, and diffusive solute transfer among pore domains with different velocities. Under field conditions, an additional dominant factor contributing to dispersion is the large-scale heterogeneity in soil hydraulic and chemical properties. Such heterogeneities may arise from the presence of preferential flow paths (cracks, fissures, biochannels) as well as spatial variability in soil hydraulic properties. Complex models, based on fundamental laws governing various processes influencing herbicide transport in soils, may be constructed. Such models have been useful in enhancing the understanding of herbicide behavior in soils and for guiding research efforts. However, validation and use of such models at the field scale, has been limited by the lack of detailed data for input parameters and output variables. Simple models may provide 'reasonable' predictions of herbicide behavior under field conditions. Validation of even these models has been hampered by lack of reliable field data and collaborative efforts to collect the necessary data. A number of herbicides have been detected in groundwater. More are likely to be found as systematic groundwater monitoring effects that include more sampling locations and analyses for more pesticides are completed. (See also W90-06164) (Lantz-PTT)
W90-06166

HERBICIDES IN SURFACE WATERS.
Georgia Coastal Plain Experiment Station, Tifton.
R. A. Leonard.
IN: Environmental Chemistry of Herbicides. Volume I. CRC Press, Inc., Boca Raton, Florida. p 45-87, 10 fig, 4 tab, 136 ref.

Descriptors: *Herbicides, *Path of pollutants, *Pesticides, *Surface water, *Water pollution sources, Agricultural runoff, Aquatic environment, Atrazine, Dissolved solids, Picloram, Water pollution effects.

Dispersion of pesticide residues into the environment by surface runoff from agricultural lands has been a major concern for about the last 20 years. Early concerns centered primarily on the persistent chlorinated hydrocarbon insecticides which were transported by both water and air from their site of application. Herbicides used in agriculture currently constitute the greatest tonnage of all pesticides. Although some herbicides are acutely toxic to fish, the hazard of herbicides to the aquatic environment is small compared to insecticides. With a few exceptions, herbicides have little toxicity to humans, wildlife, and livestock. Herbicides may destroy or suppress aquatic vegetation, producing both desirable and undesirable effects. Growth inhibition of submerged aquatic vegetation is reported in the presence of 60 to 1040 micrograms/L (ug/L) atrazine, depending on species. Few effects were observed at concentrations of 10 microg/L. The presence of herbicide residues, such as picloram, may also impact the quality of water for irrigation of sensitive crops. This chapter covers processes and factors that determine quantities and distribution of pesticides in surface waters emanating from treated lands, and modeling technology for assessing the predicting herbicide runoff. (See also W90-06164) (Lantz-PTT)
W90-06167

DISSIPATION FROM SOIL.
Agricultural Research Service, Beltsville, MD. Pesticide Degradation Lab.
IN: Environmental Chemistry of Herbicides. Volume I. CRC Press, Inc., Boca Raton, Florida. p 131-169, 9 fig, 11 tab, 137 ref.

Descriptors: *Herbicides, *Path of pollutants, *Pesticides, *Soil contamination, Dissipation, Energy, Mathematical analysis, Mathematical equations, Mathematical studies, Theoretical analysis.

Dissipation of pesticides on surface soil, in rhizosphere soil, and, presumably, in subsoil usually follows a simple exponential equation, which is a lumped sum of all the loss pathways and the chemical and environmental factors affecting dissipation. An equation developed from a given data set theoretically is valid only for that data set and should not be used to estimate pesticide dissipation under different conditions without additional testing and calibration. If there are not alternatives, or additional means to test or validate the equation, its application must be considered with caution. Dissipation activation energies (delta-E)(Arrhenius equation) have been determined for several pesticides. The activation energies can be used to estimate pesticide dissipation under conditions like those from which the dissipation activation energies were determined, but should be used only with caution under different conditions. A conceptual approach, in which the dissipation rate from each loss pathway is defined and in which environmental influence are reflected, has the greatest potential because true kinetics can be assigned. When pesticide dissipation is primarily by volatilization, several theoretical and empirical equations have been derived to estimate pesticide flux. Subsequently, the dissipation rate can be estimated from the flux and original amount. Some empirically derived equations (which include some of the pesticide physicochemical characteristics and environmental parameters) appear to be capable of estimating pesticide dissipation from soil surfaces. All of the empirically derived equations are only valid for the data sets from which they were developed. Likewise, many of the theoretical equations may be valid only for the data sets from which they were tested, because assumptions are always made. In principle, however, the theoretical equations based upon sound thermodynamics and kinetics should prove the most useful in the long-run. (See also W90-06164) (Lantz-PTT)
W90-06168

HEALTH RISK ASSESSMENT OF 1,1,2-TRICHLOROETHANE (1,1,2-TCA) IN CALIFORNIA DRINKING WATER.
California Univ., Davis. Dept. of Environmental Toxicology.
For primary bibliographic entry see Field 5C.
W90-06169

HEALTH RISK ASSESSMENT OF 1,2-DICHLOROPROPANE (1,2-DCP) IN CALIFORNIA DRINKING WATER.
California Univ., Davis. Dept. of Environmental Toxicology.
For primary bibliographic entry see Field 5C.
W90-06170

COMPARATIVE STUDY OF PRECIPITATION CHEMISTRY AT INLAND, COASTAL AND ISLAND SITES IN THE BOTHNIAN BAY AREA.
Stockholm Univ. (Sweden). Meteorologiska Institutionen.
For primary bibliographic entry see Field 2B.
W90-06171

ENVIRONMENTAL EFFECTS AND FATE OF DECONTAMINATION AGENT C-8 IN SOIL.

Argonne National Lab., IL. Energy and Environmental Systems Div.
For primary bibliographic entry see Field 5C.
W90-06173

BIOMOVS: AN INTERNATIONAL MODEL VALIDATION STUDY.
Statens Straalskyddsinstitut, Stockholm (Sweden).
C. Hagg, and G. Johansson.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-754036. Price codes: A02 in paper copy, A01 in microfiche. Report No. SSI-rapport 87-32, November 16, 1987. 11p, 1 fig, 1 tab, 5 ref.

Descriptors: *BIOMOVS, *Biospheric Model Validation Study, *Fate of pollutants, *Model studies, *Path of pollutants, *Radioactive wastes, Aquatic environment, Chernobyl incident.

BIOMOVS (Biosphere Model Validation Study) is an international study using models to compare and test the distribution of radioactive and nonradioactive trace substances in terrestrial and aquatic environment. The main objectives were to compare and test the accuracy of predictions between such models, explain differences in these predictions, recommend priorities for future research concerning the improvement of the accuracy of model predictions and act as a forum for the exchange of ideas, experience and information. Two approaches were used. Approach A compares model predictions with actual field data. Within this 'model validation' approach five scenarios were treated. Two scenarios are already in the 'validation phase', namely, 'release of mercury in a river' and 'iodine-131 and cesium-137 in milk, beef, and v/barley after the Chernobyl accident'. For the iodine-131 and cesium-137 study twelve independent sets of data have been contributed and a more or less ideal situation exists for validating the models. The alternative test procedure, Approach B, intercomparison and testing of models, was used when it was not possible to test models against independent data. The scenarios 'release into a lake from a river' and 'irrigation with contaminated groundwater' have been completed. For the other B-scenarios, only preliminary results exist. The scenario 'release into a lake from a river' and 'aging of a lake' treat waterborne radionuclides that reach water reservoirs and are related to assessment studies for radioactive waste and mining facilities. However, in these scenarios the interface between the biosphere and geosphere was not modelled. In order to address this problem, the two scenarios 'transport of contaminated water to soil and to a river' were formulated. These two scenarios deal with groundwater borne radionuclides that reach the biosphere via surface soil or sediment. (Lantz-PTT)
W90-06174

EVALUATION OF THE SECONDARY EFFECTS OF AIR STRIPPING.
Montgomery (James M.), Inc., Pasadena, CA.
For primary bibliographic entry see Field 5F.
W90-06180

ASSESSMENT OF THE POTENTIAL FOR TRANSPORT OF DIOXINS AND CODISPOSED MATERIALS TO GROUNDWATER.
Maryland Univ., College Park. Dept. of Civil Engineering.
R. W. Walters, Z. Yousefi, A. L. Tarleton, S. A. Ostazeski, and D. C. Barry.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-166607. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/6-89/002, March 1989. 101p, 32 fig, 20 tab, 40 ref. EPA Contract CR813601.

Descriptors: *Dioxins, *Groundwater pollution, *Path of pollutants, Benzenes, Chemical analysis, Chlorination, Kinetics, Soil contamination, Sorption.

Dioxins are very toxic contaminants and warrant study under a variety of experimental conditions. Studies were performed to evaluate the mobility of several of the dioxins in both soil columns as well as in batch experiments. The studies showed that the amount of chlorination did not necessarily control the partitioning of the dioxins, as expected, but also suggested that the structure or location where the Cl ion was attached to the benzene ring modified the hydrophobicity of the compound. Studies were performed with a variety of cosolvents which might mediate the movement of the dioxin. The observed modification in mobility was consistent with existing theory for enhanced mobility with truly miscible solvents. Experimental data appears to show reversibility in the sorption process, but is significantly limited by kinetics with 30 to 50 days required to release 50-90% of the contaminant. (Author's abstract)
W90-06182

EVALUATION AND PREDICTION OF HENRY'S LAW CONSTANTS AND AQUEOUS SOLUBILITIES FOR SOLVENTS AND HYDROCARBON FUEL COMPONENTS. VOLUME I: TECHNICAL DISCUSSION.
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 7B.
W90-06183

FLOW AND TRANSPORT IN POROUS FORMATIONS.
Tel-Aviv Univ. (Israel). Dept. of Fluid Mechanics and Heat Transfer.
For primary bibliographic entry see Field 2F.
W90-06188

CONTAMINATED SEDIMENTS: LECTURES ON ENVIRONMENTAL ASPECTS OF PARTICLE-ASSOCIATED CHEMICALS IN AQUATIC SYSTEMS.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
U. Forstner.
Springer-Verlag, New York, New York. 1989. 157 p.

Descriptors: *Path of pollutants, *Sediment contamination, *Water pollution sources, Cadmium, Dredging, Dredging wastes, Lake Ontario, Niagara River, Puget Sound, Rhine River, Rotterdam Harbor, Speciation, Spoil banks.

Sediments are increasingly recognized as both a carrier and a possible source of contaminants in aquatic systems. These materials may also affect groundwater quality and agricultural products when disposed on land. Modern research on particle-bound contaminants probably originated with the idea that sediments reflect the biological, chemical and physical conditions in a water body. Based on this concept the historical evolution of limnological parameters could be traced back from the study of vertical sediment profiles. Since the early part of the century, limnological research on eutrophication problems and acidification indicated that particle-interactions can affect aquatic ecosystems, e.g., by enhancing the mobility of toxic metals. In contrast to the eutrophication and acidification problems, research on toxic chemicals has included sediment aspects from its beginning. In the lecture notes, following the description of priority pollutants related to sedimentary phases, four aspects were covered, which in an overlapping succession also reflect the development of knowledge in particle-associated pollutants during the past 25 years: the identification, surveillance, monitoring and control of sources and distribution of pollutants (Chapter 3); the evaluation of solid/solution relations of contaminants in surface waters (Chapter 4); the study of in-situ processes and mechanisms in pollutant transfer in various compartments of the aquatic ecosystems (Chapter 5); and, the assessment of the environmental impact of particle-bound contaminants, i.e. the development of sediment quality criteria (Chapter 6). The last chapter focuses on dredged materials, including their disposal and the treatment of strongly contaminated sediments. Cases studies include the Niagara River/Lake Ontario pollution; solid speciation of metals in river sediments; the Rhine River; Puget Sound; Rotterdam Harbor; and the mobilization of cadmium from tidal river sediments. (Lantz-PTT)
W90-06189

NATIONAL BENTHIC SURVEILLANCE PROJECT: PACIFIC COAST. PART I: SUMMARY AND OVERVIEW OF THE RESULTS FOR CYCLES I TO III (1984-86).
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
U. Varanasi, S.-L. Chan, B. B. McCain, M. H. Schiewe, and R. C. Clark.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-180632. Price codes: A04 in paper copy, A01 in microfiche. NOAA Technical Memorandum NMFS F/NEC-156, December 1988. 64p, 21 fig, 36 ref.

Descriptors: *Baseline studies, *Benthic environment, *Coastal waters, *Pacific Ocean, *Path of pollutants, *Water pollution sources, *Water quality, Alaska, Aromatic compounds, California, Chlorinated hydrocarbons, Hydrocarbons, Insecticides, Metals, Oregon, Polychlorinated biphenyls, Tissue analysis, Washington.

Employing highly uniform sampling protocols and state-of-the-art analytical methods, a comprehensive database has been developed, which includes detailed information on the distribution of a variety of chemical contaminants. These contaminants include selected aromatic hydrocarbons, PCBs, organochlorine insecticides and metals in surficial sediments and in liver tissue, bile, and stomach contents of selected bottom-feeding fish. This technical memorandum is the first part of a two-part report which summarizes the results of the first 3 years of the West Coast portion of NBSP. Part I is an overview of findings and is not intended to be an in-depth treatment of these data; a more comprehensive presentation and detailed treatment of these data can be found in the Technical Part (Part II) of this report. The overall finding from the NBSP for the years 1984-86 indicated that the highest concentrations of most sediment-associated contaminants were present in the highly urbanized areas and that contaminants were bioavailable to indigenous marine species. No correlation was found between concentrations of most of the measured metals in sediment and in liver tissue of the target fish species. Of all the sites sampled, the most contaminated sites were located in San Diego Bay, Commencement Bay (Tacoma), Elliott Bay (Seattle), and San Pedro Bay (Los Angeles/Long Beach). (Author's abstract) (See also W90-06198)
W90-06197

NATIONAL BENTHIC SURVEILLANCE PROJECT: PACIFIC COAST. PART II: TECHNICAL PRESENTATION OF THE RESULTS FOR CYCLES I TO III (1984-86).
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
U. Varanasi, S.-L. Chan, B. B. McCain, M. H. Schiewe, and R. C. Clark.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-180632. Price codes: A04 in paper copy, A01 in microfiche. NOAA Technical Memorandum NMFS F/NEC-170, September 1989. 248p, 48 fig, 10 tab, 96 ref, append.

Descriptors: *Baseline studies, *Benthic environment, *Coastal waters, *Coastal waters, *Pacific Ocean, *Path of pollutants, *Water pollution sources, *Water quality, Alaska, Aromatic compounds, California, Chlorinated hydrocarbons, Hydrocarbons, Insecticides, Metals, Oregon, Polychlorinated biphenyls, Tissue analysis, Washington.

Employing highly uniform sampling protocols and state-of-the-art analytical methods, a comprehensive database has been developed, which includes detailed information on the distribution of a variety of chemical contaminants. These contaminants include selected aromatic hydrocarbons, PCBs, organochlorine insecticides and metals in surficial sediments and in liver tissue, bile, and stomach contents of selected bottom-feeding fish. This tech-

nical memorandum is the second part of a two-part report which summarizes the results of the first 3 years of the West Coast portion of NBSP. Part II includes descriptions of sampling strategies and analytical methods, as well as a detailed presentation of the data. The Results and Discussion Section addresses the principal findings and compares them with those previously reported. The overall finding from the NBSP for the years 1984-86 indicated that the highest concentrations of most sediment-associated contaminants were present in the highly urbanized areas and that contaminants were bioavailable to indigenous marine species. No correlation was found between concentrations of most of the measured metals in sediment and in liver tissue of the target fish species. Of all the sites sampled, the most contaminated sites were located in San Diego Bay, Commencement Bay (Tacoma), Elliott Bay (Seattle), and San Pedro Bay (Los Angeles/Long Beach). (Author's abstract) (See also W90-06197)
W90-06198

ROLE OF SUB-SURFACE CONTAMINANT FATE AND TRANSPORT MODELS FOR RCRA LAND BAN REGULATIONS.
Kuo and Associates, McLean, VA.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-002863. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/FE/60972--T1, July 1988. 34p, 1 fig, 2 tab, 10 ref, append. DOE Contract DE-AC01-86FE60972.

Descriptors: *Fate of pollutants, *Model studies, *Path of pollutants, *Resource Conservation and Recovery Act, *Solute transport, Aeration zone, Groundwater pollution, Regulations.

For planning and program implementation purposes, it is crucial that the Office of Fossil Energy (OFE) maintain a cognizance of and be responsive to the hazardous waste regulatory process. A major part of this process involves EPA's use of, and reliance on, subsurface contaminant fate and transport models. This report includes an overview of the requirements and complexity of groundwater and solute fate and transport models, and considers the predictive value of existing models for both aquifers and unsaturated soils. The material is presented so as to be of practical value to OFE in understanding and commenting on models used by EPA in its rule-making and regulatory activities. Of specific interest is the EPACML model, EPA's new 'back calculation model' (replacing EPASMOD) that will be used in the promulgation of RCRA land disposal regulations. As is the case with the back calculation model which is still being used by EPA, EPACML will probably incorporate assumptions and system constraints that will not be applicable to most landfill/unsaturated zone/aquifer/receptor well systems. Accordingly, the findings and recommendations include: (1) any numerical solute transport model should be field tested and validated before being used for regulatory or water management purposes; (2) no two landfill/unsaturated zone/aquifer/receptor well systems are alike; (3) unsaturated zone solute transport models are much less advanced, and less reliable, than saturated zone solute transport models; (4) the utility of any numerical solute transport model is a direct function of the 'quality of data inputs; and (5) the EPACML model should allow for an unsaturated zone, and variable distances from landfill to receptor wells, and variable soil and aquifer properties. (Lantz-PTT)
W90-06200

PHYSICAL TEST FACILITY FOR MODELING OPEN-WATER PLACEMENT OF DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-06206

SUPERFUND RECORD OF DECISION: HASTING GROUND WATER/FAR-MAR, NE.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-06207

SUPERFUND RECORD OF DECISION: ATCHISON/SANTA FE/CLOVIS, NM.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-06208

OIL SPILL RISK ANALYSIS: CENTRAL AND WESTERN GULF OF MEXICO (PROPOSED LEASE SALES 118 AND 122) OUTER CONTINENTAL SHELF.
Minerals Management Service, Reston, VA.
L. J. Hannon, and A. D. Lucas.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-168157. Price codes: A06 in paper copy, A01 in microfiche. Report No. MMS 88-0025, May 1988. 109p, 5 fig, 11 tab, 10 ref, append.

Descriptors: *Gulf of Mexico, *Oil spills, *Risk assessment, *Water pollution sources, Environmental effects, Oil fields, Oil industry.

The Federal Government has proposed to offer Outer Continental Shelf (OCS) lands off the Gulf of Mexico coast for oil and gas leasing. Oil resources to be leased, discovered, and production of 0.10 billion barrels were estimated for the proposed action for the Western Planning Area. Oil resources for the proposed action for the Central Planning Area were estimated at 0.20 billion barrels. The oil is expected to be produced, in both planning areas, over a period of 23 years (1989-2012). A high-find scenario was also estimated as 0.23 (Western) and 0.35 (Central) billion barrels. An oil-spill risk analysis (OSRA) was conducted for the proposed Gulf of Mexico OCS Lease Sales 118 and 122. The objective of this study was to determine relative risks associated with oil production in different portions of the proposed lease sale areas. The analysis was conducted in three parts. The first part addressed the probability of oil-spill occurrence, while the second part analyzes the trajectories of oil spills from potential launch sites to various coastal resources. The third part combined results of the first two parts of the analysis to give estimates of the overall or joint oil-spill risk associated with oil production in the lease area. (Lantz-PTT)
W90-06209

PHASE I DIAGNOSTIC/FEASIBILITY STUDY COVENTRY LAKE, COVENTRY, CONNECTICUT, 1984.
Connecticut Dept. of Environmental Protection, Hartford. Water Compliance Unit.
For primary bibliographic entry see Field 5G.
W90-06210

FISH COMMUNITIES IN LAKES IN SUBREGION 2B (UPPER PENINSULA OF MICHIGAN) IN RELATION TO LAKE ACIDITY. VOLUME II: APPENDICES.
Northrop Services, Inc., Corvallis, OR.
R. F. Cusimano, J. P. Baker, W. J. Warren-Hicks, V. Lesser, and W. W. Taylor.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-161848. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/3-89/021b, March 1989. 44p. EPA Contracts 68-08-0006, 68-03-3249, 68-03-3439 and CR814030.

Descriptors: *Acid rain effects, *Acidity, *Data acquisition, *Fish populations, *Lakes, *Water pollution effects, Acid neutralizing capacity, Aluminum, Calcium, Darters, Dissolved organic carbon, Hydrogen ion concentration, Michigan, Minnow, Quality control, Silica, Surveys, Water chemistry.

Surveys of fish community status were conducted in summer 1987 in 49 lakes in Subregion 2B, the Upper Peninsula of Michigan, as part of Phase II of the Eastern Lake Survey. One of two appendices contains information on quality assurance and quality control procedures for measurements of water quality. The quality assurance system consisted of on-site evaluation of the field station and field operations, the sample processing laboratory, and the analytical laboratory. Facilities, equipment, and operations were reviewed. The second appendix contains water chemistry and fish catch data by individual lakes and sampling dates. Variables reported include lake area, watershed area, elevation, site depth, pH, concentrations of aluminum, calcium, iron, magnesium, sodium, silica, sulfate, and total phosphorus, conductivity, dissolved organic carbon, Secchi depth, and color. (See also W90-06181) (Lantz-PTT)
W90-06215

INTERIM REPORT: NITROGEN AND PHOSPHORUS LOADS FOR THE SUSQUEHANNA RIVER BASIN, 1985-1987.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
A. N. Ott, C. S. Takita, R. E. Edwards, and S. W. Bollinger.
Susquehanna River Basin Commission, Harrisburg, Pennsylvania. Publication No. 127, January 1990. 60p, 17 fig, 22 tab, 14 ref.

Descriptors: *Nitrogen, *Pennsylvania, *Phosphorus, *Susquehanna River, *Water quality, Chesapeake Bay, Maryland, Nutrients, Pollution load, Suspended sediments.

Much of the excessive nutrients and suspended sediment that enter the Chesapeake Bay are thought to originate from the lower Susquehanna basin. Several studies have shown high nutrient levels in streams in the lower basin, while other studies show high nutrient levels in groundwater in the lower basin. Three of the studies showed high suspended sediment yields from areas in the lower basin. Nutrient and suspended sediment loads transported by the main stem of the Susquehanna River and its major tributaries were measured. In addition, nutrient and suspended sediment loads were measured from a few streams that drain areas of single or nearly single land use. The annual and seasonal loads and yields of total nitrogen (TN) and total phosphorus (TP) measured during calendar years 1985, 1986 and 1987 are tabulated. A method has been developed which readily allows the estimation of an 'average baseline load' as well as a 'loading rate' to which a single figure reduction goal can be related regardless of water discharge. The loads and yields measured from the two major tributaries to the lower Susquehanna River, the main stem Susquehanna River at Harrisburg and Marietta, and selected tributaries draining the lower Susquehanna River basin are given. The total basin loads and the loads measured at Conowingo Dam by the USGS and the Maryland Office of Environmental Protection are also presented to provide an insight into the settling out of Susquehanna River nutrient loads prior to entering the Chesapeake Bay. (Lantz-PTT)
W90-06217

1990 WATER QUALITY ASSESSMENT REPORT: SUSQUEHANNA RIVER BASIN.
Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.
C. P. McMorran.
Susquehanna River Basin Commission, Harrisburg, Pennsylvania. Publication No. 130, January 1990. 51p, 17 fig, 18 tab, append.

Descriptors: *Pennsylvania, *Pollution load, *Susquehanna River, *Water pollution sources, *Water quality, Agricultural runoff, Metals, Mine wastes, Municipal wastewater, Nonpoint pollution sources, Nutrients, Suspended sediments, Wastewater pollution, Water use.

This report was prepared to meet the requirements of Section 305(b) of the Clean Water Act (CWA). The Susquehanna River drains 27,580 sq mi in New York, Pennsylvania and Maryland, and contributes over half of the freshwater inflow to the Chesapeake Bay. The report covers 13,268 stream miles assessed out of 21,100 miles of named streams

in the basin. The assessments cover the Lower Susquehanna, Juniata and West Branch subbasins in greater detail than the Upper Susquehanna, Chemung and Eastern subbasins. Designated uses are attained in 11,812 stream miles (89% of the total). Ninety-four percent (12,520 stream miles) meet the CWA fishable water goal and 99% (13,223 stream miles) meet the CWA swimmable waters goal. Metals (mainly from mining activities) are the major cause of degradation, polluting 844 stream miles (58% of impaired stream miles). Nutrient enrichment and sediment from agricultural runoff and municipal wastewater discharges account for another 19% of degraded stream miles. At least 885 stream miles have elevated levels of toxic substances, mainly metals. (Lantz-PTT)
W90-06218

GEOHYDROLOGY, SIMULATION OF GROUND-WATER FLOW, AND GROUND-WATER QUALITY AT TWO LANDFILLS, MARION COUNTY, INDIANA.
Geological Survey, Indianapolis, IN. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06223

STREAMFLOW AND STREAM QUALITY IN THE COAL-MINING REGION, PATOKA RIVER BASIN, SOUTHWESTERN INDIANA, 1983-85.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. E. Renn.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4150, 1989. 68p, 8 fig, 14 tab, 31 ref.

Descriptors: *Acid mine drainage, *Hydrologic data collections, *Indiana, *Water pollution sources, *Water quality, Agricultural watersheds, Stream discharge, Surface water.

Streamflow and stream quality data were collected in the coal mining region of the Patoka River basin, Indiana. Data were collected on the Patoka River, tributaries to the Patoka River, the South Fork Patoka River (the largest tributary to the Patoka River), and tributaries to the South Fork Patoka River. Data were collected 4 times at 29 sites from August 1983 through March 1985 during different seasons and conditions of streamflow. Data obtained at the sites included instantaneous streamflow, pH, specific conductance, dissolved-oxygen concentration, water temperature, and concentrations of alkalinity and hot acidity. Water samples were collected and analyzed to determine the concentrations of dissolved sulfate; dissolved, suspended, and total recoverable iron and manganese; dissolved solids suspended sediment; and suspended sediment finer than 0.0625-mm diameter. Streamflow in the Patoka River has been regulated since 1978 by Patoka Lake. Flow-duration analysis indicate that flow regulation by Patoka Lake generally has increased low streamflows and decreased high streamflows in the Patoka Lake. When compared to sites on the tributaries, sites on the Patoka River generally had smaller values for specific conductance and concentrations of chemical constituents. Sites on the tributaries had larger values due to the physical and chemical weathering of coal-mined material in their basins. For the tributary sites, pH was near neutral at 11 sites, pH was low at 8 sites, and pH was variable at 3 sites depending on streamflow. (USGS)
W90-06227

HYDROGEOLOGIC CHARACTERISTICS OF THE LEE ACRES LANDFILL AREA, SAN JUAN COUNTY, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06228

VARIABLE-DENSITY GROUND-WATER FLOW AND PALEOHYDROLOGY IN THE WASTE ISOLATION PILOT PLANT (WIPP) REGION, SOUTHEASTERN NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
P. B. Davies.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-490, Aug. 1989. 139p, 66 fig, 1 tab, 93 ref.

Descriptors: *Density, *Geohydrology, *Groundwater movement, *Hydrologic systems, *Model studies, *New Mexico, *Path of pollutants, *Radioactive waste disposal, Brines, Paleohydrology.

Variable-density groundwater flow was studied near the Waste Isolation Pilot Plant in southeastern New Mexico. An analysis of the relative magnitude of pressure-related and density-related flow-driving forces indicates that density-related gravity effects are not significant at the plant and to the west but are significant in areas to the north, northeast, and south. A regional-scale model of variable-density groundwater flow in the Culebra Dolomite member of the Rustler Formation indicates that the flow velocities are relatively rapid (10 to the minus 7th power m/sec) west of the site and extremely slow (10 to the minus 11th power m/sec) east and northeast of the site. In the transition zone between those two extremes, which includes the plant, velocities are highly variable. Sensitivity simulations indicate that the central and western parts of the region, including the plant, are fairly well isolated from the eastern and northeastern boundaries. Vertical-flux simulations indicate that as much as 25% of total inflow to the Culebra could be entering as vertical flow, with most of this flow occurring west of the plant. A simple cross-sectional model was developed to examine the flow system as it drains through time following recharge during a past glacial pluvial. This model indicates that the system as a whole drains very slowly and that it apparently could have sustained flow from purely transient drainage following recharge of the system during the Pleistocene. (USGS)
W90-06230

RECONNAISSANCE HYDROGEOLOGIC INVESTIGATION OF THE DEFENSE WASTE PROCESSING FACILITY AND VICINITY, SAVANNAH RIVER PLANT, SOUTH CAROLINA.
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06245

SALINITY AND FLOW RELATIONS AND EFFECTS OF REDUCED FLOW IN THE CHASSAHOWITZKA RIVER AND HOMOSASSA RIVER ESTUARIES, SOUTHWEST FLORIDA.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 2L.
W90-06249

5C. Effects Of Pollution

FORECAST OF STABILITY OF BED LOAD IN UNSTABLE CHANNELS.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
For primary bibliographic entry see Field 2J.
W90-05706

EFFECT OF DISSOLVED OXYGEN CONCENTRATIONS ON FISH AND INVERTEBRATES IN LARGE EXPERIMENTAL CHANNELS.
Tennessee Valley Authority, Knoxville. Office of Natural Resources and Economic Development.
J. H. Heuer, and W. M. Seawell.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-016074. Price codes: A03 in paper copy, A01 in microfiche. Report No. TVA/ONRED/AWR--88/14, July 1987. 34p, 8 fig, 7 tab, 14 ref, append.

Descriptors: *Dissolved oxygen, *Water pollution effects, *Fish, *Invertebrates, Bass, Catfish, Bluegills, Zooplankton, Macroinvertebrates.

The responses of fish (smallmouth bass, channel catfish, golden shiners, and bluegill), zooplankton, and benthic macroinvertebrates to various levels of dissolved oxygen (DO) were monitored in six large outdoor channels at the Tennessee Valley Authority (TVA) Aquatic Research Laboratory at Browns Ferry Nuclear Plant. Nitrogen stripping was used to remove oxygen from the water, and aquatic organisms were exposed to target levels of 5,4,3, and 2 mg/L (2 channels) and to an untreated control from July 24, 1984 until September 24, 1984. Nitrogen stripping proved to be an effective and reliable method of attaining low DO concentrations. However, DO levels fluctuated during the experiment because of oxygen produced and consumed by aquatic plants in the channels. Average values in the channels during the study were 5.7, 4.5, 4.1, 2.9, and 7.0 mg/L. Minimum DO concentrations were close to target levels, but there was considerable daily and longitudinal fluctuation in the channels. Response of adult golden shiners, bluegill, and channel catfish to DO were not consistent, probably because of predation by smallmouth bass on golden shiners and competition between bluegill and channel catfish. Bluegill spawned successfully only in the control. Smallmouth bass exhibited the highest total weight and survival in the control channel. Next highest weights were recovered from the 5 mg/L treatment. Zooplankton did not show a consistent response to DO, probably because of predation by fish. Benthic invertebrates showed some response to DO. Two types of snails were not collected in the 2 mg/L treatment. One type of midge larva was less abundant in the 2 mg/L treatment whereas another type was more common there. One type of biting midge larvae was collected from the 3 and 2 mg/L channels. (Lantz-PTT)
W90-05751

PROTECTION OF RIVER BASINS, LAKES AND ESTUARIES: FIFTEEN YEARS OF COOPERATION TOWARD SOLVING ENVIRONMENTAL PROBLEMS IN THE USSR AND USA.
For primary bibliographic entry see Field 6G.
W90-05772

USE OF MESOCOSMS IN EVALUATING THE HEALTH OF AQUATIC ECOSYSTEMS.
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
For primary bibliographic entry see Field 7C.
W90-05780

ION EXCHANGE IN FISH UNDER EXTREME EFFECTS OF A VARIED NATURE.
Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.
G. A. Vinogradov, V. T. Komov, and V. B. Tagunov.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 212-244, 5 fig, 3 tab, 46 ref.

Descriptors: *Environmental effects, *Fish physiology, *Ion exchange, *Pesticides, *Stress, *Toxicology, *Water pollution effects, Calcium, Chlorides, Magnesium, Polychlorpinene, Potassium, Sodium, Toxicity.

The stocking of fresh waters with teleost fish and their successful adaptation would not be possible without the formation of physiological mechanisms ensuring homeostasis of osmotic concentration and ion composition in the internal medium. The hyperosmotic state of the internal medium in fish, as in crustaceans, is maintained through high concentrations of Na(+) and Cl(-) (120-140 millimols (mmols)/L) compared to the external medium. The ion content of K(+), Ca(2+) and Mg(2+) is significantly lower (1.5-5.0 mmols/L). NaCl diffuses into the water as a result of the high gradient of concentrations between the internal and external mediums. Part of these ions are excreted with the urine. The regularities of ion exchange between the fish and the medium with individual living condi-

tion deviations from the optimal values was established. It was determined that catching and laboratory handling of fish are the same type of stress factors, inducing disturbances of the ion balance between the organism and medium through intensification of Na and K diffusion into the external medium. At the start of the stress period (< 1 hr after the effect begins), the ion loss increases sharply. The ion exchange characteristics stabilize and the cation exchanges become normal in the restorative period, lasting a maximum of 2 days. Sodium losses drop repeatedly and Na absorption from the water increases as a result of the fish acclimation to the salt shortage in the water. Similar adaptive changes also take place in Ca exchange. The presence of Ca(2+) in the external medium reduces the Na and K leaving the organism. Mg(2+) depress Ca absorption from the water. 50% of Ca transport inhibition is observed with a Mg concentration close to 50 micromols/L. The adequate duration of the experiments (20 days) and the use of toxicant concentrations close to sublethal, established the differences in the action of widespread pesticides on fish gill functions. Polychlorpinene increases Na loss from the organism. Other pesticides in different concentrations do not have such an effect. (See also W90-05772) (Lantz-PTT)
W90-05781

AQUATIC TOXICITY METHODOLOGIES: AN UPDATE FOR THE 1980S.
National Fisheries Research Center-Great Lakes, Ann Arbor, MI.
M. G. Henry, and R. A. Schoettger.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 245-261, 2 tab, 31 ref.

Descriptors: *Bioassay, *Biological studies, *Toxicity, *USSR, *Water pollution effects, Algae, Bioaccumulation, Ecological effects, Ecosystems, Fish, International commissions, Lethal limit, Microbiological studies.

Hazard assessment approaches and techniques are consistently being refined in the face of escalating industrial, domestic, and agricultural point and nonpoint inputs of contaminants to water supplies. Integral to hazard assessment are methods for determining the biological effects of single compounds and mixtures on non-target organisms. The ultimate goal is to produce meaningful regulations that preserve aquatic biota and yet still allow for wise utilization of streams, rivers, lakes, and their indigenous fish. Prior to 1975, when the first US-USSR Joint Symposium and Interlaboratory Exchange dedicated to issues of water pollution prevention occurred, the only influence exerted by Soviet scientists on their peers in the US and vice-versa was through the published literature, often difficult to obtain or translate, and through presentations at scientific meetings. In what might be philosophically viewed as a double-blind experiment prior to 1975, the evolution of thought pertaining to test methods development in each country can be chronologically traced and compared. The objectives of this paper are three-fold: (1) review the general categories of toxicity tests independently used in the US and USSR prior to the signing of the Bilaterial Agreement in 1972 and the first technical exchange in 1975, (2) discuss collaborative methods that have been developed since the first technical exchange, and (3) discuss some distinctive features of research directions in the US and USSR that complement collaborative efforts and aid in determining future research emphasis in the development of toxicity test methods. The methods discussed from the USSR are: acute lethality; partial chronic; full-cycle; microbial assays; algal assays; behavioral; biochemical/physiological; histological; organoleptic evaluations; limited field surveys; microbial assays; ponds; and zooplankton community investigations. The methods discussed from the US are: acute lethality; embryo-larval; full-life cycle; algal assays; histological; bioaccumulation; field surveys; diversity; and microcosms. (See also W90-05772) (Lantz-PTT)
W90-05782

BIOTESTING OF AQUATIC ENVIRONMENTS BASED ON THE BEHAVIORAL REACTIONS OF AQUATIC ANIMALS.
Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.
For primary bibliographic entry see Field 5A.
W90-05783

AMMONIA TOXICITY AND METABOLISM IN FISHES.
Environmental Research Lab., Athens, GA.
R. C. Russo, D. J. Randall, and R. V. Thurston.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 283-310, 3 fig, 1 tab, 90 ref.

Descriptors: *Ammonia, *Fish, *Toxicity, *Water pollution effects, Dissolved oxygen, Hydrogen ion concentration, Nitrogen compounds, Temperature.

Ammonia can enter natural water systems from several sources, including industrial wastes, sewage effluents, alternative fuel conversion processes, and agricultural discharges. It is also a natural biological degradation production of nitrogenous organic matter. To understand the toxicity of ammonia to fish, it is important to understand its chemical equilibrium in water. In aqueous solutions, ammonia assumes two chemical forms: the unionized form (NH3), hydrogen bonded to at least three water molecules; and the ionized form (NH4(+)). Total ammonia is the sum of NH3 and NH4(+), and it is total ammonia that is measured analytically in aqueous solution. The relative concentrations of ionized and unionized ammonia in a given ammonia solution are principally a function of the pH, temperature, and ionic strength of that solution. As pH increases, the equilibrium is shifted toward the unionized species, and the concentration of NH3 increases while that of NH4(+) decreases. Temperature increase also favors the NH3 species, but to a lesser extent. The interaction between ammonia and dissolved oxygen (DO) is an important factor in ammonia toxicity to aquatic life. Discharge of ammonia is frequently associated with a reduction of oxygen levels in the receiving water. This is brought about by several causes, including the oxygen demand of the ammonia as it is converted by: (1) the natural microbial oxidation to nitrite and nitrate, (2) the chemical and biological oxygen demand of other chemicals that may be discharged along with ammonia, and (3) the reduction in oxygen-carrying capacity of the receiving water caused by a high temperature discharge. Aquatic life in streams receiving discharges containing ammonia may often be subjected to fluctuations in ammonia concentration, as opposed to steady or constant concentrations, and when accidental spills of ammonia occur, aquatic organisms may be subjected to large slugs of ammonia for short periods of time. Prior exposure of fish to ammonia appears to increase their tolerance to acutely lethal concentrations. This relationships may significantly affect the instantaneous and short-term maximum concentrations of ammonia that fish can tolerate in instances of accidental releases or spills. (See also W90-05772) (Lantz-PTT)
W90-05784

AIR POLLUTION AND ACIDIFICATION.
National Swedish Environment Protection Board, Solna.
For primary bibliographic entry see Field 5B.
W90-05789

EVALUATION AND ANALYSIS OF THREE DYNAMIC WATERSHED ACIDIFICATION CODES (MAGIC, ETD, AND ILWAS).
Battelle Pacific Northwest Labs., Richland, WA.
E. A. Jenne, L. E. Eary, L. W. Vail, D. C. Girvin, and A. M. Liebetrau.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-006388. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/3-89/045, June 1989. 227p, 9 fig, 43 tab, 77 ref, 5 append. DOE Contract DE-AC06-76RLO-1830.

Descriptors: *Acid rain, *Acid rain effects, *Acidification, *Model studies, *Neutralization, *Simulation, *Water pollution effects, Chemical interactions, Clear Pond, Forecasting, Geochemistry, New York, Panther Lake, Woods Lake.

The EPA is currently using the dynamic watershed acidification codes MAGIC (Model of Acidification of Groundwater in Catchments), ETD (Enhanced Trickle-Down), and ILWAS (Integrated Lake Watershed Acidification Study) to assess the impact of acidic deposition on water quality by simulating watershed acid neutralization processes. The process formulations (i.e., conceptual and numerical representation of atmospheric, hydrologic, geochemical and biogeochemical processes) were evaluated, their approaches to calculating acid neutralizing capacity (ANC) were compared, and the relative effects (sensitivity) of perturbations in the input data on selected output variables for each code were estimated. Input data were drawn from three Adirondack watersheds: Panther Lake, Clear Pond, and Woods Lake. The MAGIC and ILWAS codes contain process-oriented formulations based on principles of thermodynamic equilibria and kinetics for the following geochemical and biogeochemical processes: (1) silicate mineral weathering, (2) anion adsorption, (3) cation exchange, (4) aluminum hydroxide dissolution and speciation, (5) carbonic acid equilibria, and (6) organic acid speciation. The additional process detail in the ILWAS code has the advantages of allowing more measurement data in the calibration process and more interpretation of the relative importance of various biogeochemical processes. However, the MAGIC code has the advantage of requiring fewer input data, thereby requiring the estimation of values for fewer variables, and less time to calibrate. The ETD code, in contrast to the MAGIC and ILWAS codes, integrates watershed processes by expressing their effects on the ANC mass balance. This approach is based on the role of ANC as the prime indicator of surface water acidification. Limitations inherent in this code include the absence of reactions of important geochemical components, process detail, and the choice of kinetic expressions for base-cation exchange reactions. (Lantz-PTT)
W90-05790

RISK ASSESSMENT OF CHEMICALS IN THE ENVIRONMENT.
Royal Society of Chemistry, London, England.
579 p. Edited by Mervyn L. Richardson.

Descriptors: *Chemical wastes, *Hazardous wastes, *Radioactive wastes, *Risk assessment, *Water pollution effects, Air pollution, Conferences, Toxicology, Water pollution, Water pollution control.

Risk assessment is a multidisciplinary subject with worldwide consequences. These proceedings cover the third European Conference on Chemistry and the Environment as formulated by the Federation of European Chemical Society's (FECS) Working Party on Chemistry and the Environment. With worldwide contributions from eminent, internationally known authors, the book covers both chemical and radioactive risk assessment, predictive techniques, risk acceptance (including prediction and reality on isolated and global bases), approaches to the control of chemical disasters and much more. It is divided into four sections: introduction and overview; contribution of toxicology to risk assessment; incidental emissions--air and water; and international emissions. (See W90-05793 thru W90-05802) (Lantz-PTT)
W90-05792

ACID RAIN--MODELLING ITS RISKS TO THE EUROPEAN ENVIRONMENT.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
L. Hordijk.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 298-311, 7 fig, 1 tab, 27 ref.

Descriptors: *Acid rain, *Air pollution, *Europe, *Model studies, *Path of pollutants, *Rain, *Risk

assessment, *Water pollution sources, Acidification, Regional Acidification Information and Simulation, Soil contamination, Sulfur, Sulfur dioxide.

As the public debate on acid deposition escalates, governments and industry are hard pressed to decide whether to install additional controls on powerplants and clean up other potential sources of pollution; to take steps to mitigate possible effects of acid deposition (e.g. liming of waterways and soils, development of resistant biota); or to wait perhaps 5 or 10 years until there is more conclusive information about the complex relationship between emissions and environmental effects. At the International Institute for Applied Systems Analysis (IIASA) in Austria the Regional Acidification Information and Simulation (RAINS) model has been developed to synthesize the vast amount of unstructured information abut acidification and for dealing with the many crucial uncertainties associated with pollution emissions and their environmental effects. The emphasis of RAINS is on the transboundary aspect of air pollution. Therefore, the spatial coverage is all of Europe, including the European part of the USSR, and the time period is from 1960 up to 2040. The model is currently sulfur-based because of the principal role of sulfur dioxide as a precursor of acid deposition. However, the model is being expanded to include emissions of oxides of nitrogen and ammonia. RAINS consists of three linked compartments: pollutant generation, atmospheric processes, and environmental impacts. The energy and emissions submodel accounts for five emissions producing sectors: conversion, powerplants, domestic, industry, and transportation. In addition, eight fuels are considered: brown coal, derived coal, light oil, medium distillates, heavy oils, gas, and 'other fuels'. There are basically four different ways to reduce emissions of sulfur dioxide from energy combustion: (1) energy conservation, (2) fuel substitution, (3) use of fuels containing less sulfur, and (4) desulfurization during or after combustion. RAINS contains procedures for options 2-4. Soil acidification is an important link between air pollution and effects on the terrestrial and aquatic environment. The RAINS soil submodel deals only with forest soils and its working is based on the soil's ability to buffer acid deposition. (See also W90-05792) (Lantz-PTT)
W90-05793

TOTAL INDEX OF ENVIRONMENTAL QUALITY AS APPLIED TO WATER RESOURCES.
Ceske Vysoke Uceni Technicke v Praze. Fakulta Jaderna a Fysikalne Inzenyrska.
For primary bibliographic entry see Field 6B.
W90-05795

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIPS AND TOXICITY ASSESSMENT IN THE AQUATIC ENVIRONMENT.
Environmental Protection Agency, Washington, DC. Office of Toxic Substances.
R. L. Lipnick.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 379-397, 3 tab, 48 ref.

Descriptors: *Risk assessment, *Structure-activity relationships, *Toxicity, *Toxicology, *Water pollution effects, Chemical analysis, Model studies.

Quantitative structure-activity relationships (QSARs) are a valuable tool for systematizing toxicity data on aquatic organisms as a function of chemical structure. The application of QSAR models for predictive purposes requires some knowledge or insight into molecular mechanism of toxicity; otherwise, the toxicity of a new, untested industrial chemical may be underestimated. The narcosis model provides an estimate of baseline toxicity for non-electrolytes in general. Therefore, such a new substance can be assumed to be at least as toxic as these narcosis QSAR predictions, which are limited only by the ability to assign reliably a log P value (P = octanol/water partition coefficient). A chemical should be considered as a candidate for chronic toxicity testing if its log P exceeds the maximum value permitting the attainment of equilibrium partitioning in the chosen test duration, or if evidence exists for cumulative toxicity via an electrophile or other more specific toxicity mechanism. (See also W90-05792) (Lantz-PTT)
W90-05796

HAZARD AND RISK ASSESSMENT AND ACCEPTABILITY OF CHEMICALS IN THE ENVIRONMENT.
Technical Univ. of Denmark, Lyngby. Lab. of Environmental Science and Ecology.
F. BroRasmussen.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 437-450, 4 fig, 12 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Risk assessment, *Toxicity, *Water pollution effects, Bioaccumulation, Environmental effects, Pollutant identification.

In spite of well-established practices to determine environmental risks and hazards, it is still important to present a conceptual framework for the evaluation of risk from environmental chemicals. This permits the development of reasonably stringent definitions, and the exercising of a more narrow range of interpretations than normally found in this context. A few examples of environmental risk assessments are presented, and the observation is made, that the acceptability is as important for the assessment, as are the risk criteria per se. Although the standards for risk acceptance are variable, the hazard evaluation is often described in terms of a step-wise procedure which distinguishes between the hazard identification (HI) and the hazard assessment (HA). The HI identifies hazardous properties inherent to the chemicals, e.g., persistence, bioaccumulative potential, toxicity, and possibly selected properties which indicate environmental mobility and reactivity. HI concludes in classification or categorization of chemicals in numerical or otherwise prioritized order. HA assesses the potential for a chemical to cause harm (adverse effects) to targets or target systems, such as human population, environmental species and/or ecosystems. HA concludes in identification of targets at risk related to potential exposure and exposure routes. Risk estimation (RE) estimates the probability that a chemical causes harm (adverse effects) as a result of a specified production, use and/or other emission into the environment. RE concludes in a relationship (probabilistic or quality related) between potential target-effect data and data on acceptable or unacceptable effects. (See also W90-05792) (Lantz-PTT)
W90-05799

METABOLISM OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE AQUATIC ENVIRONMENT.
For primary bibliographic entry see Field 5B.
W90-05812

FACTORS INFLUENCING EXPERIMENTAL CARCINOGENESIS IN LABORATORY FISH MODELS.
Oregon State Univ., Corvallis. Dept. of Food Science and Technology.
G. S. Bailey, D. E. Goeger, and J. D. Hendricks.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 253-268, 7 tab, 62 ref. Public Health Service Grant Nos. ES00092, ES00210, ES00541, ES03850, CA34732, and CA398398.

Descriptors: *Cancer, *Carcinogens, *Fish, *Laboratory methods, *Model studies, *Toxicity, *Water pollution effects, Water temperature.

The likely impact of an environmental carcinogen on any fish population will depend on the amount of exposure received by each susceptible life-stage, the ability of each stage to absorb and metabolize the carcinogen and to repair any ensuing damage, and the genetic consequences for tumor induction per unit of genomic damage in target organs at each developmental age. Studies were reviewed that demonstrate that in laboratory models, several additional factors may have significant impact on the population response to a given chemical carcinogen. These include, but may not be limited to, developmental age at exposure, route of exposure, genetic variation, nutritional status and growth rate, nutrient and non-nutrient modulators of carcinogenicity, and water temperature during initiation and/or growth. When considered individually, the effect of each parameter on experimental carcinogenicity seems not be great, generally less than one order of magnitude. However, it may be a rare circumstance that only one such variable will be operative in comparison of tumor incidences among feral fish populations. More frequently, some combination of several such variables may operate, along with carcinogen exposure, to determine the tumor incidence in populations under comparison. Since most of these variables function independently, in some instances their environmentally random occurrence may combine to profoundly alter the tumor incidence among populations under comparison, and confound any attempt to ascribe tumor incidence solely to variation in exposure to a suspect environmental carcinogen. The major impediment to identification of specific etiological agents in feral fish neoplasia may well be the difficulties imposed by the existence of highly complicated mixtures of genotoxic compounds. This will be superimposed on an intermittent and variable exposure of host species to compounds which can modulate fish response to environmental carcinogens. (See also W90-05812) (Lantz-PTT)
W90-05820

PAH, METABOLITES, AND NEOPLASIA IN FERAL FISH POPULATIONS.
National Fisheries Contaminant Research Center, Columbus, OH. Field Research Station.
P. C. Baumann.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 269-289, 7 fig, 4 tab, 74 ref.

Descriptors: *Bioaccumulation, *Cancer, *Fish, *Metabolism, *Polycyclic aromatic hydrocarbons, *Toxicity, *Water pollution effects, Benzopyrene, Black River, Case studies, Field studies, Laboratory methods, Lake Erie, Puget Sound, Sediment contamination, Tissue analysis.

The hypothesis that anthropogenic polycyclic aromatic hydrocarbons (PAH) cause epizootics of neoplasia in feral fish rests primarily on research at three locations: (1) Puget Sound, Washington; (2) eastern Lake Erie; and (3) the Black River, Ohio. Case histories of these three sites have a number of similarities. Frequency of liver neoplasia, including both cholangicellular and hepatocellular lesions, was high in bottom-dwelling fishes at each location. Bottom sediments in the areas that these fish populations inhabited contained elevated levels of PAH, including known mammalian carcinogens such as benzo(a)pyrene (BaP). The PAH concentrations were typically several orders of magnitude greater than those recorded from less polluted areas. Skin painting experiments with PAH extracted from sediments produced papillomas in brown bullheads (Buffalo River sediment) and in Swiss mice (Buffalo and Black River sediments). Furthermore, elevated levels of PAH were found in the stomach contents of English sole and white suckers from populations with high frequencies of neoplasia. Elevated PAH levels have been demonstrated in fish tissue from all three research areas. Experiments with English sole and brown bullhead have demonstrated the ability of both species to metabolize BaP to carcinogenic derivatives, and have documented the subsequent formation of DNA adducts. Bile of feral fish from all locations has been found to contain PAH metabolites. A recent experiment demonstrated that hepatic carcinoma can be induced in rainbow trout by exposure to dietary BaP. Although this research taken as a whole does not demonstrate cause and effect, the field studies and the results of laboratory investigations can best be interpreted by assuming the pathology to be the result of a carcinogen taken by fish from their environment by way of the diet, or by water and sediment intake or contact, and acti-

vated by hepatic enzymes. (See also W90-05812) (Lantz-PTT)
W90-05821

HYDROCARBONS IN MARINE MOLLUSKS: BIOLOGICAL EFFECTS AND ECOLOGICAL CONSEQUENCES.
Marine Biological Association of the United Kingdom, Plymouth (England).
M. N. Moore, D. R. Livingstone, and J. Widdows.
IN: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press, Inc., Boca Raton, Florida. p 291-328, 11 fig, 7 tab, 201 ref.

Descriptors: *Bioaccumulation, *Hydrocarbons, *Mollusks, *Polycyclic aromatic hydrocarbons, *Water pollution effects, Biological studies, Biotransformation, Ecological effects.

Polycyclic aromatic hydrocarbons (PAH) represent a major class of environmental contaminant originating from both petrogenic and pyrogenic sources. Marine organisms, including mollusks, accumulate PAH in their body tissues and concentrate them to a marked degree over seawater levels. The quantity, form, biological fate, and effects of toxic environmental contaminants such as PAH are determined by interactions between a number of processes, including uptake (absorption), distribution, accumulation (storage), biotransformation (metabolism), and elimination (excretion and depuration). Understanding of many of these processes is limited in marine organisms. Many PAH are capable of being transformed to carcinogenic or cocarcinogenic derivatives in mammals by the cytochrome P-450 monooxygenase- and epoxide hydratase systems. An integrated approach to the areas of bioaccumulation, biotransformation, and biological effects and their ecological consequences is presented. It is emphasized that while the focus is on PAH, many of the environmental examples described relate to petroleum-derived xenobiotics, which include not only PAH, but also aliphatic hydrocarbons, as well as heterocyclic compounds. The possibility of contributory effects due to these other components cannot, be ruled out. The prime objective of this work has been to identify and investigate the processes involved in the responses to hydrocarbons at different levels of biological organization (i.e., molecular, subcellular, cellular, tissue/organ, individual, and population), whether these can be conceptually linked in order to gain an understanding of how the animal responds to hydrocarbons and to attempt to predict what the possible ecological consequences might be. An additional objective is the development of indices of harmful effects at the various hierarchical levels of biological organization. (See also W90-05812) (Lantz-PTT)
W90-05822

TOXICITY OF VERTICAL SEDIMENTS IN THE TRENTON CHANNEL, DETROIT RIVER, MICHIGAN, TO CHIRONOMUS TENTANS (INSECTA: CHIRONOMIDAE).
Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.
C. J. Rosiu, J. P. Giesy, and R. G. Kreis.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 570-580, 1989. 3 fig, 2 tab, 37 ref. EPA Cooperative Agreement No. DL 85-002-06.

Descriptors: *Bioassay, *Detroit River, *Midges, *Sediment contamination, *Water pollution effects, *Water pollution treatment, Cores, Economic aspects, Macroinvertebrates, Spatial variation, Testing procedures, Toxicity.

The effects of sediment from various sediment core depths on survival and weight gain of larvae of the dipteran midge, Chironomus tentans were studied in 10-d laboratory exposures. Sediment cores were collected from 12 sites in the Trenton Channel of the Detroit River in 1987 and sectioned into 5-cm intervals to a depth of 25 cm. Percent reductions in larval weight gain, relative to that in control sediment, were calculated for each interval. Two sites were classified as very toxic, three sites as toxic, three sites as slightly toxic, and four sites as good quality benthic habitat. The utility of sediment core toxicity profiling and the C. tentans bioassay for three-dimensional sediment quality assessment are analyzed as well as comparisons between the results of laboratory assays and field surveys of benthic macroinvertebrates. The assay results are used to estimate the volume of toxic sediment at eight sites and determine the costs of dredging and disposal of the toxic sediments. Preliminary estimates of remedial actions were developed to achieve several levels of mitigation of the toxicity of sediment to macrozoobenthic populations in the Trenton Channel. (Author's abstract)
W90-05843

USE OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) TO MONITOR THE NEARSHORE ENVIRONMENT OF LAKES.
University of Western Ontario, London. Dept. of Zoology.
For primary bibliographic entry see Field 5A.
W90-05849

RESPONSE OF SPORT FISHES TO THERMAL DISCHARGES INTO THE GREAT LAKES: IS SOMERSET STATION, LAKE ONTARIO, DIFFERENT.
State Univ. of New York Coll. at Brockport. Dept. of Biological Sciences.
J. M. Haynes, G. P. Gerber, and J. K. Buttner.
Journal of Great Lakes Research JGLRDE, Vol. 15, No. 4, p 709-718, 1989. 1 fig, 2 tab, 62 ref.

Descriptors: *Fish behavior, *Lake Ontario, *Thermal pollution, *Water pollution effects, Fish tagging, Salmonines, Sunfish, Thermal attraction.

To assess potential thermal impacts of Somerset Generating Station on sport fishes, the frequencies and durations of encountering the thermal discharge at Somerset Station were determined by tagging 121 salmonines and 58 centrarchids with temperature-sensing radiotransmitters. Encounters of Lake Ontario shoreline occupied by Somerset Station averaged 0.7 and 0.1 per fish for salmonines and centrarchids, respectively. Salmonines averaged 5.5 h at the station per encounter. Four centrarchids established residence areas in the lake near the station for 28-79 d; others averaged 3.5 d at the station. Salmonines and centrarchids occupied waters off Somerset Station on 6.7% and 16.0%, respectively, of the days they were tracked. No temperatures occupied by fish at the station exceeded critical thermal maxima for salmonines (20-25 degrees C) or centrarchids (30-37 degrees C). Salmonines occupied heated water >2C degrees above ambient lake temperatures on 1.3% of the 1,983 occasions when temperatures were recorded, while centrarchids averaged 0.1% of 1,773 observations. Rare encounters of and lack of attraction to the thermal discharge were attributed to characteristics of the discharge (600+ m offshore, small delta T, small volume/area), to unremarkable lake habitat (flat bottom, physically similar to other regions of southcentral Lake Ontario), and to the generally wide-ranging movements of fishes in Lake Ontario. Comparing results from Somerset Station with similar studies at other Great Lakes power stations suggests that discharge design and lake habitat importantly influence the extent of fish attraction to thermal discharges. (Author's abstract)
W90-05855

SURVEILLANCE: THE FOUNDATION FOR CONTROL AND ELIMINATION OF DRACUNCULIASIS IN AFRICA.
WHO Collaborating Center for Research, Training, and Control of Dracunculiasis, Atlanta, GA.
For primary bibliographic entry see Field 7A.
W90-05873

NORTH SEA BENTHOS: A REVIEW OF FIELD INVESTIGATIONS INTO THE BIOLOGICAL EFFECTS OF MAN'S ACTIVITIES.
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
For primary bibliographic entry see Field 4C.
W90-05874

GULF OF MEXICO HYDROCARBON SEEP COMMUNITIES: PART III. AROMATIC HYDROCARBON CONCENTRATIONS IN ORGANISMS, SEDIMENTS AND WATER.
Texas A and M Univ., College Station. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W90-05876

INFLUENCE OF TWO TRIAZINE HERBICIDES ON THE PRODUCTIVITY, BIOMASS AND COMMUNITY COMPOSITION OF FRESHWATER MARSH PERIPHYTON.
Manitoba Univ., Winnipeg. Dept. of Botany.
S. E. Gurney, and G. G. C. Robinson.
Aquatic Botany AQBODS, Vol. 36, No. 1, p 1-22, December 1989. 12 fig, 33 ref.

Descriptors: *Algal growth, *Aquatic productivity, *Herbicides, *Marsh plants, *Periphyton, *Triazine pesticides, *Water pollution effects, *Wetlands, Algae, Aquatic weed control, Biomass, Chlorophyta, Diatoms, Nutrients, Photosynthesis, Species composition.

Triazine herbicides are used for the control of terrestrial weeds, aquatic macrophytes and nuisance algae. The primary and secondary effects of simazine and terbutryn on freshwater marsh periphyton were evaluated. Haptobenthic algae colonizing acrylic substrata and herpobenthic algae living within the sediment were monitored within in-situ herbicide-treated and control PVC (polyvinyl chloride) enclosures. Simazine (2.0 mg/L) and terbutryn (0.01 mg/L) treatment of haptobenthic communities produced photosynthetic inhibition during the first two weeks of exposure, whereas the herpobenthic community remained inhibited throughout the 84 day sampling period. Haptobenthic chlorophyll a content also increased after the period of inhibition. Although algal cell numbers of this community were similar in both treatments to that of the control, biovolume data indicated significant inhibition throughout the experimental period. Large filamentous chlorophytes, which dominated the biomass of the control community, were replaced by similar diatom species in treated communities. Secondary effects of herbicide treatment included increases in dissolved nutrients and decreases in dissolved oxygen. Increases in phosphorus and ammonia were correlated with accelerated productivity rates of treated communities. (Author's abstract)
W90-05894

INGESTION OF ENVIRONMENTALLY CONTAMINATED LAKE ONTARIO SALMON BY LABORATORY RATS INCREASES AVOIDANCE OF UNPREDICTABLE AVERSIVE NONREWARD AND MILD ELECTRIC SHOCK.
State Univ. of New York Coll. at Oswego.
H. B. Daly, D. R. Hertzler, and D. M. Sargent.
Behavioral Neuroscience BENEDJ, Vol. 103, No. 6, p 1356-1365, December 1989. 6 fig, 1 tab, 22 ref.

Descriptors: *Animal behavior, *Avoidance, *Bioassay, *Lake Ontario, *Lake fisheries, *Rats, *Salmon, *Toxicology, *Water pollution effects, Heavy metals, Mathematical models, Path of pollutants, Polychlorinated biphenyls, Sublethal effects, Toxicity.

There is growing evidence that suggests that ingestion of contaminated fish by mammals causes physiological and behavioral changes, and researchers have attributed these effects to some combination of the chemicals found in Great Lakes fish. To determine what behavioral changes are caused by consumption of Lake Ontario salmon, a 30% diet of Lake Ontario or control Pacific Ocean salmon was fed to rats for 20 days. In Experiments 1 and 2 (preference-for-predictability E-maze test), rats fed Lake Ontario salmon developed a preference for predictable food rewards more quickly than did the control rats. In Experiments 3 (passive avoidance) and 4 (conditioned suppression), rats fed Lake Ontario salmon suppressed responding to food far more after the introduction of mild electric shocks than did control rats. All results supported the hypothesis that ingestion of Lake Ontar-

io salmon, contaminated with polychlorinated biphenyls, mercury, lead, etc., increases the reactivity of rats to aversive events. The results were successfully simulated by DMOD (Daly MODification of the Rescorla-Wagner model), a mathematical model of learning, using the assumption that rats fed Lake Ontario salmon find unpredictable nonreward and mild shock more aversive. (Author's abstract)
W90-05907

MULTIVARIATE ANALYSIS OF LAKE PHYTOPLANKTON AND ENVIRONMENTAL FACTORS.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 2H.
W90-05920

INTERACTIVE EFFECTS OF ACIDITY AND ALUMINUM EXPOSURE ON THE LIFE CYCLE OF THE MIDGE CHIRONOMUS RIPARIUS (DIPTERA).
National Fisheries Contaminant Research Center, Columbia, MO.
D. U. Palawski, J. B. Hunn, D. N. Chester, and R. H. Wiedneyer.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 155-162, December 1989. 55 tab, 25 ref.

Descriptors: *Acid rain effects, *Acidity, *Aluminum, *Hydrogen ion concentration, *Life cycles, *Midges, *Synergistic effects, *Toxicity, *Water pollution, Acidic water, Chironomus, Larval growth stage, Lethal limit, Survival.

The chronic toxicity of acidic pH and the toxicity of aluminum at pH 5.6 and pH 5.0 to the midge Chironomus riparius were determined in 30-day flow-through exposures. Larvae were exposed to water pHs of 7.2, 6.2, 5.8, 5.3, and 4.5; total aluminum concentrations were 14.6, 34.8, 61.4, 128.7, and 259.2 microgram/L at a water pH of 5.6 and to aluminum concentrations of 15.6, 32.5, 56.9, 111.4, and 235.2 microgram/L at a water pH of 5.0. The survival of midges was only 11 % at pH 4.5 and 52.3 % at pH 5.8. In soft water (12 mg/L as $CaCO_3$) at pH 5.6, survival declined significantly at aluminum concentrations of 61 to 259 microgram/L, but significantly increased at 14.6 microgram/L. In soft water at pH 5.0, survival increased at concentrations of 14.6 to 111.4 microgram/L, but decreased significantly at 235.2 microgram/L. At both pH 5.6 and pH 5.0, the toxicological response of midges to aluminum was thus bimodal, in that acid stress was slightly ameliorated by relatively low aluminum concentrations, but exacerbated by higher concentrations. (Mertz-PTT)
W90-05930

COPPER TOXICITY FOR BLUE-GREEN ALGAE WITH REFERENCE TO THEIR PHYSIOLOGICAL STATUS.
Humboldt-Univ. zu Berlin (German D.R.). Sektion Biologie.
For primary bibliographic entry see Field 2H.
W90-05938

TOLERANCE TOWARDS MERCURY OF CHLORELLA STRAINS DETERMINED BY ALGAL PLATING.
Rome Univ. (Italy). Dipt. di Biologia.
P. Albertano, G. Pinto, A. Pollio, and R. Taddei.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 82, No. 4, p 461-468, December 1989. 3 fig, 1 tab, 21 ref.

Descriptors: *Algal growth, *Chlorella, *Chlorophyta, *Mercury, *Toxicity, *Water pollution effects, Bioassay, Taxonomy, Tolerance.

The resistance towards mercury of 45 strains of Chlorella was examined using a plate diffusion assay. Paper disks impregnated with mercury inhibited the growth of cultures of Chlorella on agar plates. The inhibition of growth increased with the concentration of mercury. The screening demonstrated that the tolerance towards mercury in all the species of Chlorella tested was similar; only the strains assigned to Chlorella emersonii and the type strain of Chlorella fusca var. fusca exhibited a higher resistance to mercury, probably related to the different structure of the cell wall. C. emersonii evidences the presence of an intermediate zone of inhibition, not found in the other species of Chlorella probably due to the peculiar structure of the cell wall which is double-layered, with the outer trilaminar layer containing sporopollenin. On the basis of these biochemical and ultrastructural differences of the cell wall, C. emersonii has been excluded from the genus Chlorella (subfamily Chlorelloideae) and included in the subfamily Scotiellocystoideae as Graesiella vacuolata. (Geiger-PTT)
W90-05939

FRESHWATER FISH CYTOCHROME P450-DEPENDENT ENZYMATIC ACTIVITIES: A CHEMICAL POLLUTION INDICATOR.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon (France). Lab. d'Ecotoxicologie.
For primary bibliographic entry see Field 5A.
W90-05942

PRELIMINARY STUDY OF THE TRANSLOCATION OF ALDICARB ACROSS THE DUCK EGGSHELL.
Trinity Coll., Dublin (Ireland). Dept. of Pharmacology and Therapeutics.
For primary bibliographic entry see Field 5B.
W90-05944

ECOTOXICOLOGICAL CHARACTERIZATION OF INDUSTRIAL WASTEWATER: SULFITE PULP MILL WITH BLEACHING.
Norsk Inst. for Vannforskning, Oslo.
T. Kaellqvist, G. E. Carlberg, and A. Kringstad.
Ecotoxicology and Environmental Safety EESADV, Vol. 18, No. 3, p 321-336, December 1989. 7 fig, 5 tab, 28 ref.

Descriptors: *Bleaching wastes, *Industrial wastewater, *Bleaching waste, *Pulp wastes, *Toxicology, *Waste characteristics, *Wastewater analysis, *Water pollution effects, Algae, Algal growth, Chlorinated hydrocarbons, Chlorine, Degradation, Environmental effects, Path of pollutants, Toxicity.

Different process wastewaters from a sulfite pulp mill with bleaching were characterized by chemical analysis and toxicity tests. The amount of adsorbable organically bound halogen (AOX) from the bleachery was 3.6 kilograms/ton pulp. The extractable organically bound chlorine was 15% of AOX. Some identified organochlorine compounds in the effluent could be traced in the receiving water. Effluents from the chlorination and alkaline extraction stages and the condensate were the main contributors to the effluent toxicity. The effluents were particularly toxic to the alga Skeletonema costatum. The EC50 value for growth of the alga was 24-29 ml/L of the total effluent. The toxicity cannot be ascribed to single chemical components in the effluents. Degradation of toxic components occurs after dilution of the effluents in the receiving water. The toxicity may be reduced to 30-50% of the initial toxicity within 1 wk. Predictions of toxic effects in the receiving water, based on results of toxicity tests and estimated dilution, indicate that large areas are affected by the discharges. Some observations of the distribution of organisms in the receiving water indicate that predictions from the toxicity tests may be valid. (Author's abstract)
W90-05945

CADMIUM-INDUCED PROTEINS FROM MYTILUS GALLOPROVINCIALIS: POLAROGRAPHIC CHARACTERIZATION AND STUDY OF THEIR INTERACTION WITH CADMIUM.
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
B. Raspor, J. Pavicic, and M. Branica.
Marine Chemistry MRCHBD, Vol. 28, No. 1-3, p 199-214, December 1989. 4 fig, 2 tab, 33 ref.

Descriptors: *Bioaccumulation, *Cadmium, *Mussels, *Mytilus, *Path of pollutants, *Proteins, Adsorption, Bioindicators, Polarographic analysis, Water pollution effects.

Mussels, Mytilus galloprovincialis, were exposed for 22 days to 230 micrograms Cd/cu dm of flowing seawater. Crude homogenate was untreated and thermally treated at 70 C for 10 min. Supernatant of 27,000 g was fractionated on a Sephadex G-75 column at 4 C. Five fractions from the metallothionein-like-proteins group, containing different concentrations of cadmium-and sulfur-containing proteins, were selected and investigated for cadmium complexing capacity by titration with increasing cadmium concentrations, at pH 1.3 and 8.5. In isolated proteins from both untreated and thermally treated homogenates, two types of binding sites were recorded at 25 C and 0.7 molar ionic strength. The first, strong binding site L1 is available at an average cadmium concentration of .00000011 moles/cu dm. The average stability constant K1 of the CdL1 complex is 170 million cm dm/mole. The second, weaker binding site L2 is available at an average cadmium concentration of .00000022 moles/cu dm, and average stability constant K2 of the complex CdL2 is 2 million cu dm/mole. Based on the stepwise stability constants K1 and K2, the overall stability constant Beta 2 has been calculated as 300,000 billion/sq (cu dm/mole). (Author's abstract)
W90-05970

KEJIMKUJIK PARK--ONE IN A FAMILY OF INTEGRATED WATERSHED STUDIES.
Atmospheric Environment Service, Downsview (Ontario). Long-Range Transport of Airborne Pollutants Program.
For primary bibliographic entry see Field 5B.
W90-05977

PRECIPITATION CHEMISTRY IN NOVA SCOTIA: 1978-1987.
Nova Scotia Dept. of the Environment, Halifax.
For primary bibliographic entry see Field 5B.
W90-05978

DIATOM-INFERRED PH HISTORY OF KEJIMKUJIK LAKE, NOVA SCOTIA: A REINTERPRETATION.
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-06002

EFFECTS OF ACIDITY AND DOC ON PHYTOPLANKTON COMMUNITY STRUCTURE AND PRODUCTION IN THREE ACID LAKES (NOVA SCOTIA).
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
S. T. Beauchamp, and J. Kerekes.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 323-333, July/August 1989. 4 fig, 4 tab, 35 ref.

Descriptors: *Acid lakes, *Acid rain, *Aquatic productivity, *Canada, *Phytoplankton, Chlorophytes, Chrysophytes, Color, Cyanophytes, Diatoms, Kejimkujik National Park, Nova Scotia, Nutrients, Organic carbon, Seasonal variation, Transparency.

Phytoplankton community structure varied between three lakes and between years within lakes located in Nova Scotia. The Beaverskin Lake phytoplankton community was dominated by cyanophytes and chlorophytes in the summer and chrysophytes in the winter. Kejimkujik Lake was dominated by bacillariophytes in the summer of 1979, but no single group dominated in 1980 or 1981. Pebbleloggitch Lake phytoplankton consisted mainly of chlorophytes in 1979, but low biomass and no dominant groups characterized this lake during the growing season of 1980. Daily integral planktonic primary production measured simultaneously in the three lakes showed that in both

years annual planktonic primary production was highest in the clear water lake, Beaverskin Lake, which also had lower dissolved organic carbon concentration compared with the two dystrophic lakes. In the clear water lake annual production was similar between years, but in the two colored lakes annual production was 40% higher in the second year. The observed increases in annual production between years in the colored lakes were largely due to changes in euphotic depth resulting from variations in hydrology and dissolved organic carbon export from the lake catchments. Lower discharges in the colored lakes in 1980 were accompanied by significantly lower lake dissolved organic carbon concentrations, water color, light extinction coefficients and increased euphotic depth. Similar changes in discharge accompanied by lower dissolved organic carbon concentration in the clear water lake did not produce significant changes in water color, light extinction coefficient nor annual production between years. Rates of primary production at light optimum were consistently higher in the most colored, acidic lake indicating that relatively high rates of autotrophic production will occur under acidic conditions if nutrient supply is maintained. (Author's abstract)
W90-06003

COMPARISON OF THE MACROPHYTE COMMUNITIES OF A CLEARWATER AND A BROWNWATER OLIGOTROPHIC LAKE IN KEJIMKUJIK NATIONAL PARK, NOVA SCOTIA.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-06004

PATTERNS OF PLANKTON SPECIES, PH AND ASSOCIATED WATER CHEMISTRY IN NOVA SCOTIA LAKES.
Newfoundland Dept. of Environment and Lands, St. John's.
For primary bibliographic entry see Field 2H.
W90-06005

DISTRIBUTION, ABUNDANCE AND BIOMASS OF BENTHIC MACROINVERTEBRATES RELATIVE TO PH AND NUTRIENTS IN EIGHT LAKES OF NOVA SCOTIA, CANADA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia).
For primary bibliographic entry see Field 2H.
W90-06006

ECOLOGICAL AND PHYSIOLOGICAL RESPONSES OF ATLANTIC SALMON IN ACIDIC ORGANIC RIVERS OF NOVA SCOTIA, CANADA.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
For primary bibliographic entry see Field 2H.
W90-06007

DIFFERENCES IN ACID TOLERANCE DURING THE EARLY LIFE STAGES OF THREE STRAINS OF BROOK TROUT, SALVELINUS FONTINALIS.
Hurley Fisheries Consulting Ltd., Dartmouth (Nova Scotia).
G. V. Hurley, T. P. Foyle, and W. J. White.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 387-398, July/August 1989. 6 fig, 3 tab, 30 ref.

Descriptors: *Acid rain, *Acidic streams, *Acidic water, *Bioassay, *Canada, *Fish hatcheries, *Hydrogen ion concentration, *Trout, *Water pollution effects, Acidity, Kejimkujik National Park, Lethal effects, Mortality, Nova Scotia, Sublethal effects, Watersheds.

Brook trout (Salvelinus fontinalis) embryo and fry from three sources (an acidic watershed in Kejimkujik Park at pH 4.7 to 5.3, a neutral watershed at pH 7, a hatchery at pH 7) were exposed separately to lethal and sublethal levels of acidity (pH 7.0, 5.2, 4.7, 4.3, 3.9), beginning at fertilization. Significant differences in mortality between the strains at low pH were observed and these suggested a genetic component to acid tolerance. Mortality in the strain from the acidic watershed was the lowest, followed by the second wild strain. Survival in both wild strains at low pH was much better than survival in hatchery embryos. These differences in survival at sublethal acidity (4.7 to 7.0) were principally the result of high mortality shortly after fertilization. After this period, survival stabilized. Only at pH 4.3 did substantial mortality occur at hatching. The early embryonic stage therefore appears to be the most susceptible to sublethal acid stress in brook trout. Hatchery strain embryos were also introduced at the eyed stage at 213 degree-days. Subsequent survival of this group was better at low pH than that of hatchery embryos introduced at fertilization, thereby indicating an early or cumulative deleterious effect. Higher acidity retarded hatching in all cases. The time to 50% hatch was delayed by 1.2 degree-days with each increase of 1 micromole H+. (Author's abstract)
W90-06008

RESPONSES OF ATLANTIC SALMON (SALMO SALAR) ALEVINS TO DISSLOVED ORGANIC CARBON AND DISSOLVED ALUMINUM AT LOW PH.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
R. H. Peterson, R. A. Bourbonniere, G. L. Lacroix, D. J. Martin-Robichaud, and P. Takats.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 3999-413, July/August 1989. 7 fig, 4 tab, 39 ref.

Descriptors: *Acid rain, *Acidic streams, *Aluminum, *Fish physiology, *Salmon, *Toxicity, *Water pollution effects, Acidic water, Acidity, Anions, Lethal effects, Mortality, Organic anions, Organic matter, Sublethal effects.

Mortality of Atlantic salmon alevins in solutions containing Al and dissolved organic anions (both synthetic and natural) was correlated with Al accumulation in alevin tissues. Both mortality and accumulation could be related to the concentration differences between Al and organic anions. Mortality and body accumulation of Al both increased dramatically as total Al concentrations increasingly exceeded organic anion concentrations. Alevin growth and yolk utilization were both less rapid at inorganic monomeric Al concentrations exceeding 2 micromoles (50 microgram/L). The acidic fractions of dissolved organic matter were more effective in protecting alevins against Al toxicity than were the neutral and basic fractions. Ambient inorganic monomeric Al is probably not toxic to salmon alevins in acidic Nova Scotian streams, even during snow-melt. (Author's abstract)
W90-06009

WATER CHEMISTRY AND PHYTOPLANKTON COMMUNITIES IN ACIDIC CLEAR AND BROWN-WATER LAKES IN EASTERN FINLAND.
Maj and Tor Nessling Foundation, Helsinki (Finland).
For primary bibliographic entry see Field 2H.
W90-06010

PREDICTION OF THE ABUNDANCE OF FISHES IN LAKE SYAM.
Akademiya Nauk SSSR, Petrozavodsk. Karelskii Filial.
V. I. Getsev, Y. A. Smirnov, and O. P. Sterligova.
Journal of Ichthyology JITHAZ, Vol. 29, No. 1, p 10-18, 1989. 2 fig, 2 tab, 8 ref.

Descriptors: *Fish populations, *Lake fisheries, *Mathematical models, *Water pollution effects, *Water resources management, Commercial fishing, Eutrophication, Population dynamics, Species composition.

A mathematical model for the prediction of abundance and spatial distribution of a population of fish is tested on the ichthyofauna of Lake Syam. Natural mortality from predation, cannibalism, and stochastic elimination, commercial fishing, and mortality as a result of catastrophic anthropogenic effects are calculated to determine the additive loss in the model. The model predicts that the total biomass of Lake Syam would change insignificantly over a ten-year period, that the lake ichthyocenosis can be considered dynamically stable, that the dynamics of species composition is expected to change with time and will lead to a relatively stable biomass of predatory fish. The change in the species composition of the fish population will be unidirectional, leading to a reduction in the percentage of valuable species and a substitution by those less valuable. The eutrophication of the lake will change the species composition of the lake, and possible reductions in commercial fish catches may result. Further study would lead to the formulation of resource management options and correction of fishery exploitation. (Brunone-PTT)
W90-06014

PECULIARITIES OF RESISTANCE OF SOME FRESHWATER FISHES TO CARBOPHOS.
Gosudarstvennyi Nauchno-Issledovatel'skii Inst. Ozernogo i Rechnogo Rybnogo Khozyaistva, Leningrad (USSR).
A. N. Gantberg, M. A. Perevoznikov, V. I. Rozengart, and O. E. Sherstobitov.
Journal of Ichthyology JITHAZ, Vol. 29, No. 1, p 81-86, 1989. 2 fig, 2 tab, 20 ref.

Descriptors: *Fish physiology, *Organophosphorus pesticides, *Pesticide toxicity, *Toxicity, *Water pollution effects, Biological degradation, Carp, Enzymes, Fate of pollutants, Perch, Roach, Structure-activity relationships.

Organophosphorus compounds are widely used in the natural economy, have a relatively low stability with high biological activity. Since the toxicity of organophosphorus compounds varies widely for different fish species, it is important to develop chemicals with selective toxicity to reduce their harmful side effects on the aquatic ecosystem. The mechanism of differential resistance of perch (Perca fluviatilis), roach (Rutilus rutilus), and carp (Cyprinus carpio) to carbophos and the effects of an oxon analogue, malaoxone, was studied. Carbophos demonstrated selective toxicity to perch. Carbophos toxicity activated the formation of the antiesterase agent malaoxone in cyprinids. The degradation process of the toxicant involves carboxyl esterase. Organophosphorus compounds containing a carboxyester group in their molecular structure would be less toxic for cyprinid fishes. (Brunone-PTT)
W90-06015

EFFECT OF ENVIRONMENTAL ACIDIFICATION ON THE OLFACTORY SYSTEM OF CARP, CYPRINUS CARPIO.
Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.
P. A. Gdovskiy, and N. N. Ruzhinskaya.
Journal of Ichthyology JITHAZ, Vol. 29, No. 1, p 87-95, 1989. 4 fig, 1 tab, 13 ref.

Descriptors: *Acid rain effects, *Animal tissues, *Carp, *Enzymes, *Fish physiology, *Hydrogen ion concentration, *Lake acidification, Acclimatization, Central nervous system, Electron microscopy, Ultrastructure.

Increasing acidification of fresh waters by acid rain during recent decades has become a serious problem. Biological effects of acidification begin at a pH of 6.5. Changes in the physiological, morphological, and biochemical parameters of the peripheral section of the olfactory system of carp, Cyprinus carpio, showed the effects of environmental acidification. Electron microscopic study of the ultrastructure of the olfactory epithelium showed that low sensitivity is characterized by high activity of the secretory elements and an increase in the quantity of olfactory mucus produced. The mucus pH shifts from normal to .4 pH more acid. Carboanhydrase activity in the olfactory lining triples. The mechanism of acclimatization of the olfactory system of carp to acidification is under the control

of the central nervous system and the sympathetic cholinergic system. (Brunone-PTT)
W90-06016

EFFECT OF TEMPERATURE AND FOOD ON HEXAVALENT CHROMIUM TOXICITY TO THE MARINE NEMATODE MONHYSTERA DISJUNCTA.

Ghent Rijksuniversiteit (Belgium). Zoology Inst.
G. Vranken, C. Tire, and C. Heip.
Marine Environmental Research MERSDW, Vol. 27, No. 2, p 127-136, 1989. 4 fig, 4 tab, 23 ref. European Economic Community Environmental Programme Grant ENV-767-B.

Descriptors: *Chromium, *Foods, *Marine pollution, *Nematodes, *Temperature effects, *Toxicity, *Water pollution effects, Hazard assessment, Larval growth stage, Mortality, Synergistic effects.

Most studies dealing with the toxicity of chemicals to nematodes have been conducted under optimal conditions. In nature, however, all animals live under fluctuating environmental conditions. The influence of temperature, food and hexavalent chromium on mortality and developmental rate was determined for the larvae of the marine bacterivorous nematode Monhystera disjuncta. When mortality was considered, temperature significantly influenced chromium toxicity ($P <= 0.001$), whereas food did not affect chromium toxicity. When development inhibition is used as the toxicity criterion, both temperature ($0.001 <= P <= 0.01$) and food ($P <= 0.001$) influenced chromium toxicity. The interaction between temperature and food is not significant for both criteria studied. It is concluded that environmental variables (abiotic and biotic) influence chromium toxicity and that this has to be taken into account in hazard assessment studies. (Author's abstract)
W90-06019

UPTAKE AND CATABOLISM OF TRIBUTYLTIN BY BLUE CRABS FED TBT CONTAMINATED PREY.

National Marine Fisheries Service, Auke Bay, AK. Auke Bay Lab.
S. D. Rice, and J. W. Short.
Marine Environmental Research MERSDW, Vol. 27, No. 2, p 137-145, 1989. 1 fig, 2 tab, 13 ref.

Descriptors: *Antifoulants, *Biodegradation, *Crabs, *Crustaceans, *Organotin compounds, *Path of pollutants, *Pesticides, *Water pollution effects, Absorption, Animal physiology, Degradation products, Metabolism, Shrimp, Toxicity.

Accumulation and catabolism of tributyltin (TBT) was measured in blue crabs (Callinectes sapidus) after 16-day exposures to TBT-contaminated prey. Tributyltin and the metabolites, dibutyltin and monobutyltin, were separated by gas chromatography and measured by atomic absorption in prey and in crab tissues during the 16-day test. Crabs were fed grass shrimps Palaemonetes pugio contaminated with 1.8 micrograms tributyltin, 0.09 micrograms dibutyltin, and 0.03 micrograms monobutyltin per gram wet weight tissue. Feeding rates for exposed and non-exposed crabs were equal during the 16-day test. In 16 days, exposed crabs consumed about 2.02 micrograms of tributyltin. Tributyltin was sequentially debutylated in a significant manner by blue crabs, but not by the grass shrimp. Tributyltin concentrations peaked in crabs after 4 days of feeding, at 0.12 micrograms per gram, Dibutyltin peaked at 8 days at 0.39 micrograms per gram, and monobutyltin peaked at 12 days at 0.35 micrograms wet weight tissue. Total butyltins reached equilibrium by 8 days, but the relative toxic burden declined from 8 to 16 days because the proportion of tributyltin continued to decline. Growth, molting success and feeding rates were not affected in the juvenile crabs during the 16-day test. Catabolism of tributyltin reduces tissue concentrations of tributyltin, thereby increasing the tolerance of blue crabs to tributyltin. (Author's abstract)
W90-06020

ASSESSMENT OF DI AND TRI-BUTYLTIN INTERACTION WITH SKELETAL MUSCLE MEMBRANES.

Industrial Toxicology Research Centre, Lucknow (India). Biomembrane Lab.
A. A. Ali, R. K. Upreti, and A. M. Kidwai.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 29-38, January 1990. 4 fig, 1 tab, 19 ref.

Descriptors: *Antifoulants, *Biological membranes, *Frogs, *Organotin compounds, *Pesticide toxicity, *Tin, *Toxicity, *Water pollution effects, Animal tissues, Bioassay, Muscle, Path of pollutants, Sarcolemma, Sublethal effects, Tissue analysis.

Organotin compounds are widely used as fungicides, miticides, biocides, surface disinfectants, anthelmintic and marine antifungal agents, but are also known to exert toxic effects in man and animals. Muscle cell membranes are the most exposed target sites for the interaction of environmental pollutants. In this the paper binding of di-butyltin and tri-butyltins were studied on frog skeletal muscle sarcolemma (muscle cell membranes) and basement membrane. Membrane preparations from the Common Indian frog (Rana tigrina) were incubated in 0 to 500 micromolar solutions of dibutyltin dichloride or tributyltin chloride for 15 min at 37 C. Free and bound organotin compounds were then determined by scatchard analysis using the dithizone assay. The binding of dibutyltin dichloride with sarcolemma was increased with increasing concentration. Maximum binding was about 0.04 micromoles tin compound/mg protein with saturation at 350 micromoles; ninety percent binding was found within 5 minutes incubation (0.0371 micromoles/mg protein). No significant differences in binding of dibutyltin dichloride at varying pH and buffers were observed. Thiol compounds were used to antagonize the binding of tributyl tin dichloride with sarcolemma. Binding was almost completely abolished at concentrations of 10 micromoles of dithiothreitol, and 200 micromoles of glutathione or cysteine. At 500 micromoles beta-mercaptoethanol the total binding effect was reduced only 67%. This binding inhibition suggests a possible involvement of sulfhydryl groups of the sarcolemma protein in binding dibutyl tin dichloride. (VerNooy-PTT)
W90-06034

FATE OF DIETARY CADMIUM AT TWO INTAKE LEVELS IN THE ODONATE NYMPH, AESHNA CANADENSIS.

Trent Univ., Peterborough (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-06036

LIFE TABLE EVALUATION OF THE EFFECTS OF CADMIUM EXPOSURE ON THE FRESHWATER CLADOCERAN, MOINA MACROCOPA.

Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.
C. K. Wong, and P. K. Wong.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 135-141, January 1990. 5 fig, 1 tab, 10 ref.

Descriptors: *Cadmium, *Life cycles, *Median tolerance limit, *Toxicity, *Water pollution effects, *Waterfleas, Aquaculture, Bioassay, Fish food organisms, Heavy metals, Hong Kong, Lethal limit, Mortality, Path of pollutants, Sublethal effects, Survival.

In Hong Kong, Moina macrocopa Straus is common in small ponds and rice paddies and is mass cultured by local fish farmers as a fish food. The life table method was used to study the effect of cadmium (Cd) on the survival and reproductive capacity of this freshwater cladoceran. Moina macrocopa were from laboratory cultures raised from a single parthenogenetic female. Groups of 20 or 30 neonates were exposed in beakers to 0 (control), 0.001, 0.005, 0.01, 0.1, 1, 5, and 10 mg Cd/L. Test solutions were changed every 24 hours, and all animals were observed through their life spans. Survivorship at 0.01 mg/L and all higher concentrations was significantly different from survivorship at lower concentrations. The time until death of half of the group of animals (LT50) was less than 50% that of control, and at 5 and 10 mg/L was less than 24 hours. Animals at 0.1 mg/L and higher concentrations did not survive to the onset of reproduction, and fecundity at 0.005 and 0.01 mg/L was significantly different that of control and 0.001 mg/L groups. The net reproductive rate at 0.005 mg/L was 44% that of control, and the net reproductive rate was just around 1 at 0.01 mg/L. Results show that although the survivorship of M. macrocopa was not affected by Cd at 0.005 mg/L or lower concentrations, fecundity and net replacement rate were clearly reduced as a result of exposure to Cd at this level or above. (VerNooy-PTT)
W90-06040

CADMIUM UPTAKE AND TOXICITY TO WATER HYACINTH: EFFECT OF REPEATED EXPOSURES UNDER CONTROLLED CONDITIONS.

Tel-Aviv Univ. (Israel). Inst. for Nature Preservation Research.
For primary bibliographic entry see Field 5D.
W90-06042

RAPID DETECTION OF SUBLETHAL TOXICITY USING FISH VENTILATORY BEHAVIOR.

Biological Monitoring, Inc., Blacksburg, VA.
For primary bibliographic entry see Field 5A.
W90-06044

SWIMMING BEHAVIOR AS AN INDICATOR OF SUBLETHAL TOXICITY TO FISH.

Fish and Wildlife Service, Columbia, MO.
E. E. Little, and S. E. Finger.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 13-19, 1990. 1 tab, 44 ref.

Descriptors: *Fish behavior, *Sublethal effects, *Swimming, *Toxicity, Aquatic animals, Behavior, Bioassay, Reviews, Water pollution effects.

Swimming behavior of fish is impaired by exposure to a diversity of contaminants. Gross aberrations in swimming can be qualitatively assessed while subtle changes in swimming behavior arising from sublethal exposures can be detected through a more detailed analysis of this response. Compared to other swimming behavior variables, the physical capacity to swim against water flow tends to be affected at relatively high toxicant concentrations and often presages mortality. Orientation to water flow, however, is altered at sublethal concentrations. Frequency of activity is a more sensitive measure in detecting contamination than measurements of survival alone. Alterations in swimming behavior have been detected during exposures to various contaminants at concentrations as low as 0.7 to 5% of their LC50 values and at concentrations that subsequently inhibited growth after longer periods of exposure. Analysis of swimming patterns provides even higher resolution for analysis of swimming behavior, and increased availability of the instrumentation necessary for such measurements should facilitate use of this approach. Fish swimming activity can easily be incorporated in test protocols to expand the sensitivity of standard toxicity tests. (Author's abstract)
W90-06045

BEHAVIORAL SCREENING ASSAY FOR DAPHNIA MAGNA: A METHOD TO ASSESS THE EFFECTS OF XENOBIOTICS ON SPACIAL ORIENTATION.

NIEHS Marine and Freshwater Biomedical Core Center, Milwaukee, WI.
For primary bibliographic entry see Field 5A.
W90-06046

BEHAVIORAL TOXICITY SYNDROMES: A PROMISING TOOL FOR ASSESSING TOXICI-

TY MECHANISMS IN JUVENILE FATHEAD MINNOWS.
Environmental Research Lab.-Duluth, MN.
R. A. Drummond, and C. L. Russom.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 37-46, 1990. 2 tab, 10 ref, append.

Descriptors: *Bioassay, *Bioindicators, *Fish behavior, *Minnow, *Sublethal effects, *Toxicity, *Water pollution effects, Animal tissues, Behavior, Biochemistry, Fish toxins, Morbidity, Morphology, Organic compounds, Tissue analysis.

Fathead minnows (Pimephales promelas) were exposed to acutely toxic concentrations of organic chemicals under flow-through conditions at 25 C for 96 hours. Changes in behavior and morphology were systematically recorded to develop a plan for classifying these chemicals. On this basis, three behavioral toxicity syndromes were evident. Each syndrome appears to represent a different general mode of toxic action. The hypoactivity syndrome, reflecting narcosis, is characterized by depressed locomotor activity, loss of startle response and very dark body coloration. The hyperactivity syndrome, representing metabolic dysfunction (e.g., uncouplers of oxidative phosphorylation), is characterized by greatly accelerated locomotor activity, overreaction to stimuli and increased ventilatory activity. The physical deformity syndrome, indicative of neurological dysfunction (e.g., acetyl cholinesterase inhibition), is characterized by a high incidence of convulsions, tetany, scoliosis/lordosis and hemorrhage in the vertebral area. This classification approach also should be useful to help delineate specific, underlying mechanisms or sites of chemical action. (Author's abstract)
W90-06048

SUBLETHAL EXPOSURE TO LEAD INHIBITS ACQUISITION AND RETENTION OF DISCRIMINATE AVOIDANCE LEARNING IN GREEN FROG (RANA CLAMITANS) TADPOLES.
Miami Univ., Oxford, OH. Dept. of Zoology.
S. Strickler-Shaw, and D. H. Taylor.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 47-52, 1990. 2 fig, 2 tab, 23 ref.

Descriptors: *Animal behavior, *Avoidance, *Frogs, *Lead, *Toxicity, *Water pollution effects, Amphibians, Bioassay, Heavy metals, Morbidity, Sublethal effects.

Animals with aquatic larval stages, such as the green frog (Rana clamitans), are potentially excellent models for investigating the effects of lead on behavior since many aquatic systems, particularly along roadways, commonly contain high concentrations of lead. In this study, green frog tadpoles were exposed to 750 micrograms Pb/L as lead nitrate. Tadpoles used in learning acquisition tests were exposed for 6 days (144 hours) and tadpoles used in retention (memory) tests were exposed for 5 days (120 hours). Both lead-exposed and control tadpoles were conditioned, using shock avoidance, to associate illumination (conditioned stimulus) with shock (unconditioned stimulus). The mean response time, fnumber of avoidances and differences in the learning curves of lead-exposed and control tadpoles were compared statistically. Learning acquisition tests showed increased response times and fewer avoidances in lead-exposed as compared to control tadpoles. Retention tests showed higher response times and no avoidances in lead-exposed tadpoles as compared to controls. These results indicate that sublethal exposure to lead adversely affected both acquisition learning and memory. (Author's abstract)
W90-06049

PREFERENCE/AVOIDANCE TESTING OF WASTE DISCHARGES ON ANADROMOUS FISH.
E. H. Smith, and H. C. Bailey.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 77-86, 1990. 5 fig, 4 tab, 15 ref.

Descriptors: *Avoidance, *Fish behavior, *Fish migration, *Industrial wastes, *Laboratory methods, *Water pollution effects, Bass, Behavior, Computers, Domestic wastes, Effluent streams, Salmon, Sublethal effects, Toxicity, Trout.

In the laboratory, preference/avoidance behavioral testing was used to investigate the potential of both domestic and industrial waste discharges to interfere with the migration of anadromous fish. Various dilutions of the effluents (oil refinery effluent and domestic sewage) were tested using the behavioral response of fish as measured by linear velocity, locational position and other factors. A video-based computerized system was used to capture and analyze the behavioral data in real time. Test species were chinook salmon, Oncorhynchus tshawytscha, striped bass, Morone saxatilis and steelhead, Salmo gairdneri. Dilution rates were established based upon dye studies and waste field dispersion modeling. Dilutions down to 1,000:1 were tested and evaluation of the potential for each discharge to affect fish migrations were made. Both attraction and avoidance responses were observed at different concentrations of the discharges studied. Test fish exhibited strong responses at levels as low as 1,000:1 of effluent. Laboratory behavioral data were compared with field surveys where possible. Once behavioral baselines derived from the animals' response range are established, significant departures from these can be used to measure the effect of a perturbation. The guidelines to determine the response level were conservative. Preliminary statistical techniques were robust and significant differences were indications of actual behavioral changes. (VerNooy-PTT)
W90-06052

RESPONSES OF GREEN FROG (RANA CLAMITANS) TADPOLES TO LEAD-POLLUTED WATER.
Miami Univ., Oxford, OH. Dept. of Zoology.
D. H. Taylor, C. W. Steele, and S. Strickler-Shaw.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 87-93, 1990. 1 fig, 5 tab, 21 ref.

Descriptors: *Animal behavior, *Avoidance, *Frogs, *Lead, *Toxicity, *Water pollution effects, Amphibians, Bioassay, Heavy metals, Sublethal effects.

Green frog (Rana clamitans) tadpoles were exposed to 0, 500, 750 and 1,000 micrograms Pb/L (as lead nitrate) for 6 days (144 hours). Previous studies have shown that similar exposure to 750 or 1,000 micrograms Pb/L produces deficiencies in both acquisition and retention of learned responses in green frog tadpoles. Preference/avoidance responses and spontaneous locomotor activity of Pb-exposed and control tadpoles to plumes of lead polluted water at each concentration in an octagonal fluviarium were examined. Results indicated no significant preference or avoidance for 500, 750, or 1,000 micrograms Pb/L by either control or Pb-exposed animals, and no significant effects on the amount of locomotor activity. Preexposure of tadpoles to these concentrations of Pb did not affect the sensitivity of animals to subsequent encounters with Pb. However, there was significantly greater ($p > 0.005$; folded F test) variability in locomotor activity for tadpoles exposed to 750 and 1,000 micrograms Pb/L compared to control animals and to those exposed to 500 micrograms Pb/L. These findings suggest that variability of response is a more sensitive index of sublethal Pb toxicosis than is gross locomotor activity and that preference/avoidance responses and locomotor activity are less sensitive indices of sublethal Pb toxicosis in green frog tadpoles than is discriminate avoidance learning. (Author's abstract)
W90-06053

SUBLETHAL TOXICANT EFFECTS ON FISH FORAGING BEHAVIOR: EMPIRICAL VS. MECHANISTIC APPROACHES.
Iowa State Univ., Ames. Dept. of Animal Ecology.
M. B. Sandheinrich, and G. J. Atchison.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 107-119, 1990. 3 fig, 4 tab, 78 ref.

Descriptors: *Experimental design, *Fish behavior, *Predation, *Sublethal effects, *Toxicity, *Water pollution effects, Behavior, Data interpretation, Fish diets, Literature review, Model studies, Simulation analysis.

Previous studies of toxicant effects on fish foraging behavior and predator-prey interactions have taken a strictly empirical approach. The most common observation of altered feeding behavior was cessation of feeding or reduction in the amount of artificial food consumed. Changes in the number of live prey attacked and captured, latency to feed and capture efficiency have also been documented. Predator-prey tests have placed major emphasis on toxicant effects on the ability of prey to escape predation. Several different test systems, as well as model ecosystems, have been used. It is difficult to evaluate the sensitivity of these behavioral tests in relation to standard chronic tests. There was no consistency in test design, and few studies provided information on chemical effects on reproduction or growth in conjunction with behavioral effects. These empirical studies have little basis in ecological theory and do not allow development of testable hypotheses a priori to field verification of laboratory results. Few laboratory feeding studies have been verified in the field. A mechanistic approach to feeding studies using optimal foraging and bioenergetics models may provide sensitive tests of contaminant effects that may be readily verified in the field. Model simulations demonstrate how toxicant effects on components of fishes' predation sequence can modify the size-frequency distribution of prey in the fishes' diet and how reductions in the amount of food consumed may alter growth. (Author's abstract)
W90-06054

STUDY OF THE PRIMARY PRODUCTIVITY IN THE SHATT AL-ARAB ESTUARY AT BASRAH, IRAQ.
Basrah Univ. (Iraq). Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-06065

ASSESSING RIVER WATER QUALITY BY MEANS OF MULTIFACTORIAL METHODS USING MACROINVERTEBRATES. A COMPARATIVE STUDY OF MAIN WATER COURSES OF BISCAY.
Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.
For primary bibliographic entry see Field 5A.
W90-06066

RESULTS OF THE HARMFUL EFFECTS OF WATER POLLUTANTS TO GREEN ALGAE (SCENEDESMUS SUBSPICATUS) IN THE CELL MULTIPLICATION INHIBITION TEST.
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
R. Kuhn, and M. Pattard.
Water Research WATRAG, Vol. 24, No. 1, p 31-38, January 1990. 5 tab, 6 ref.

Descriptors: *Bioassay, *Bioindicators, *Chlorophyta, *Water pollution effects, Biological studies, Chloramine, Chloroacetaldehyde, Monobromoacetic acid, Monochloroacetic acid, Organic compounds, Scenedesmus subspicatus.

In the Scenedesmus cell multiplication inhibition test, 68 potentially hazardous substances were examined to determine the effect of concentrations. The tests were conducted in accordance with the test procedure Deutsches Institut fuer Normung e.V. 38 412, Part 9 (draft standard). The green alga Scenedesmus subspicatus was cultivated as the test organism. Twenty-five substances were examined according to the standardized test procedure. The procedure was modified somewhat for the examination of volatile and/or strongly smelling substances. For 21 of the tested substances the effective concentrations for the 72 h and/or 48 h toxicity tests were in the concentration range 0.0001-2 mg/L. Thus, they provide very/highly toxic to the

cell multiplication of Scenedesmus subspicatus. When compared with the results of the 21 day Daphnia reproduction test, monobromoacetic, monochloroacetic acid, chloroacetaldehyde and chloramine T proved very harmful to green algae. (Author's abstract)
W90-06069

EFFECT OF SEDIMENT ON ESTIMATES OF DIQUAT TOXICITY IN LABORATORY MICROCOSMS.
Murray State Univ., KY. Hancock Biological Station.
J. R. Pratt, N. J. Bowers, and J. Cairns.
Water Research WATRAG, Vol. 24, No. 1, p 51-57, January 1990. 2 fig, 3 tab, 28 ref. EPA Grant R-812813-01-0 and Air Force Grant AFOSR-85-0324.

Descriptors: *Diquat, *Environmental effects, *Herbicides, *Microbiological studies, *Pesticides, *Sediments, *Toxicity, *Water pollution effects, Biomass, Lake sediments.

The influence of sediment on the toxicity of the herbicide diquat to microbial communities was examined in laboratory microcosms. Microbial communities collected on polyurethane foam substrata were used to establish replicate microcosms with and without sediment. After a single application of diquat, microbial community structure and function were evaluated. Three weeks after diquat treatment, communities in microcosms without sediment exhibited decreased biomass production, increased alkaline phosphatase activity, decreased dissolved oxygen production and altered protozoan species richness and composition at maximum allowable toxicant concentrations of 0.04-21.9 mg diquat/L. In microcosms amended with natural lake sediments, communities were initially affected by diquat treatment, but, by 2 weeks, dosed communities were indistinguishable from controls. Diquat disappeared rapidly in sediment-amended microcosms and could not be detected (<0.1 mg diquat/L) in any but the highest treatment after 1 week. In microcosms without sediment, 44-75% of the diquat remained in the three highest treatments after 3 weeks. Results stress the consideration of the environmental fate of chemicals in different ecosystems when designing conditions under which the toxicity of a chemical is tests. Simplistic experimental designs for toxicological studies may overestimate adverse environmental effects. (Author's abstract)
W90-06072

AQUATIC TOXICOLOGY OF ALKYL-QUINOLINES.
Environmental Protection Service, Edmonton (Alberta). Western and Northern Region.
D. A. Birkholz, R. T. Coutts, S. E. Hrudey, R. W. Danell, and W. L. Lockhart.
Water Research WATRAG, Vol. 24, No. 1, p 67-73, January 1990. 2 fig, 3 tab, 45 ref.

Descriptors: *Quinolines, *Toxicity, *Water pollution effects, Bioassay, Ethylquinoline, Fish, Isopropylquinoline, Isoquinolin, Lethal limit, Organic compounds.

Isoquinolin, 2-methyl-8-ethylquinoline, 3-isopropylquinoline, three isomers of methylquinoline and fourteen isomers of dimethylquinoline were subjected to toxicity testing using luminescent bacteria. Toxicity values (effective concentrations of the toxic substances that causes a 50% light reduction-EC50) were determined 5 and 15 mm after exposure. Toxicity values were observed to differ by two orders of magnitude and varied according to the degree of substitution and molecular structure. Static 48-h LC50 fish bioassays (Salmo gairdneri) were conducted for three isomers of dimethylquinoline. Good correlation was observed between the fish 48-h LC50 and the bacteria EC50. (Author's abstract)
W90-06074

LOW LEVELS OF ALUMINIUM CAUSING DEATH OF BROWN TROUT (SALMO TRUTTA FARIO, L.) IN A SWISS ALPINE LAKE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Toxicology.
D. Dietrich, and C. Schlatter.
Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 279-295, 1989. 6 fig, 7 tab, 38 ref.

Descriptors: *Acid rain effects, *Aluminum, *Mountain lakes, *Switzerland, *Trout, *Water pollution effects, Acidic water, Fish stocking, Ions, Synergistic effects, Toxicity.

Several attempts to stock fish in acidified alpine lakes have so far proven unsuccessful. In an effort to investigate the problems associated with the stocking of fish, the Swiss alpine lake Laiozza was chosen for experimentation. An analysis of Lake Laiozza water revealed low ion concentrations (0.5 mg Ca/L, 0.13 mg Na/L, 0.02 mg Cl/L), moderate aluminum concentrations (about 28 microg al/L), and a moderately low pH (about 5.41). As in common practice, one and two year old brown trout were exposed in a closed keep-net in Lake Laiozza. The water of Lake Laiozza proved to be acutely toxic to the fish. Mucous clogging of the gills, gill epithelial damage, plasma electrolyte losses, and high hematocrits were the predominant symptoms observed. All symptoms observed are typical for an acute intoxication with aluminum. This stands in contrast to the generally accepted view that aluminum concentrations lower than 200 microg Al/L should not be toxic to brown trout at a pH 5.4. The low Na and Cl and low Ca concentrations in the Lake Laiozza water seem to have rendered the fish much more susceptible to aluminum intoxication. (Author's abstract)
W90-06089

INVESTIGATIONS OF TROPHIC CHANGE AND INDUSTRIAL TAILINGS ACCUMULATION IN THE TRAUNSEE (AUSTRIA) USING DIATOM STRATIGRAPHY (DIATOMEEN-STRATIGRAPHISCHE UNTERSUCHUNGEN ZER TROPHIEANDERUNG UND INDUSTRIESCHLAMMAKKUMULATION IM TRAUNSEE/OSTERREICH).
Institut fuer Limnologie, Mondsee (Austria).
R. Schmidt.
Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 317-337, 1989. 11 fig, 1 tab, 45 ref. English summary.

Descriptors: *Austria, *Eutrophication, *Lakes, *Stratigraphy, *Water pollution effects, Dating, Diatoms, Industrial wastes, Traunsee.

Three cores from the Traunsee (one from the Altmunster Bay and two deep water cores) were investigated using freezing and tape-peel techniques and compared with respect to diatom stratigraphy. Two particular questions were addressed: (1) change in trophy; and (2) dating of incursions into and rate of accumulation of industrial tailings in the profundal zones. Three steps of increasing trophy supported by analysis of sediment chemistry could be recognized on the basis of lead-210 dating and annual cycles of diatoms. Since the mid 1960's the accumulation of the industrial tailings (IST), in the profundal has increased considerably. This can be correlated with flooding in 1985, 1981/82, 1978, 1975/74, and 1966. An up to 35 cm larger IST can be linked to a period of increased hydrodynamic activity in the years 1975/74. Thus in the post-1966 section average accumulation rates of 2.5-4.5 cm/year can be calculated for the investigated profundal cores. On the other hand the IST unaffected 'normal sediment' can have accumulation rates of 4-5 mm/year. Several diatom species were of particular interest: Skeletonema subsalsus in relation to chloride levels: Stephanocostis chantaicus was previously unknown in the lakes of this area; forms of Cyclotella bodanica were studied by scanning electron microscopy. (Author's abstract)
W90-06093

SUBFOSSIL AND MODERN DIATOM PLANKTON AND THE PALEOLIMNOLOGY OF ROTSEE (SWITZERLAND) SINCE 1850.
Bern Univ. (Switzerland). Systematisch-Geobotanisches Inst.
For primary bibliographic entry see Field 2H.
W90-06094

ASSESSING THE POTENTIAL EXTENT OF DAMAGE TO INLAND LAKES IN EASTERN CANADA DUE TO ACIDIC DEPOSITION. I. DEVELOPMENT AND EVALUATION OF A SIMPLE 'SITE' MODEL.
Environmental and Social Systems Analysts Ltd., Vancouver (British Columbia).
D. R. Marmorek, M. L. Jones, C. K. Minns, and F. C. Elder.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 55-66, January 1990. 8 fig, 2 tab, 43 ref, append.

Descriptors: *Acid rain, *Acid rain effects, *Data interpretation, *Lake acidification, *Model studies, *Water pollution effects, Acidification, Alkalinity, Forecasting, Hydrogen ion concentration, Ontario, Sensitivity analysis, Sulfates.

Large scale aquatic effects of acidic deposition have become a prominent environmental issue in North America and Europe. Models are required to assess the potential future impacts of current levels of acidic deposition, and the potential benefits of emission controls. A model is presented that uses measurements of current lake chemistry and assumptions about the processes governing acidification, to first estimate original (i.e. preacidification) lake chemistry and then predict the eventual chemistry expected given a specified level of acidic sulfate deposition. The model is deliberately kept simple, so that its input requirements are modest and can be met on a regional scale. When applied on a regional scale the model predicts the expected eventual distributions of alkalinity and pH. Application of the model is illustrated for a watershed in north-central Ontario, which includes the area immediately to the south and west of Sudbury. Model-based estimates of current alkalinity are very similar to observed alkalinities. The predicted eventual alkalinity distributions, given current levels of deposition, indicate a trend towards recovery, consistent with other observations in the Sudbury region. A sensitivity analysis of the model indicates that its outputs are highly sensitive to estimates of preacidification lake sulfate levels, and less so to assumptions about the catchment's ability to neutralize incoming acidity. Simple, regional models such as the one presented should play a more central role than they presently do both in assessment and in the definition of future research and monitoring needs. (See also W90-06114) (Author's abstract)
W90-06113

ASSESSING THE POTENTIAL EXTENT OF DAMAGE TO INLAND LAKES IN EASTERN CANADA DUE TO ACIDIC DEPOSITION: II. APPLICATION OF THE REGIONAL MODEL.
Environmental and Social Systems Analysts Ltd., Toronto (Ontario).
M. L. Jones, C. K. Minns, D. R. Marmorek, and F. C. Elder.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 67-80, January 1990. 7 fig, 7 tab, 49 ref.

Descriptors: *Acid rain, *Acid rain effects, *Data interpretation, *Lake acidification, *Model studies, *Water pollution effects, Acidification, Alkalinity, Forecasting, Hydrogen ion concentration, Sulfates.

The results of initial applications of the surface water acidification model to sensitive regions of eastern Canada are presented. Data used for regional application of the model were obtained from a variety of sources, including acidic sulfate deposition monitoring data and regional lake water chemistry surveys. While these data do not provide a random sample of eastern Canadian lakes, it can be argued that there are no a priori reasons for expecting highly misleading biases in the data. Results of model applications are presented for observed 1980 sulfate deposition levels and for three alternative emission scenarios. The emission scenarios were simulated using a transfer matrix derived from the AES-LRTAP model. The results suggest that substantial additional damage (declines in surface water alkalinity and pH) is expected in some regions (e.g. northeastern Ontario), even at current deposition levels. The consequences of

simple emission reduction strategies differ significantly among regions, suggesting that more complex strategies may by required to produce equitable benefits. To assist interpretation of a complex array of results, an integrated representation of regional impacts that uses quantile-quantile plots of regional distributions of lake chemistry is proposed. Finally, it is argued that while the results presented are highly uncertain, there are reasons to believe that, if anything, the damage estimates are conservative. (See also W90-06113) (Author's abstract)
W90-06114

ZOOPLANKTON SPECIES ASSOCIATIONS IN QUEBEC LAKES: VARIATION WITH ABIOTIC FACTORS, INCLUDING NATURAL AND ANTHROPOGENIC ACIDIFICATION.
Montreal Univ. (Quebec). Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-06117

EFFECTS OF ALUMINUM ON THE LEOPARD FROG, RANA PIPIENS: LIFE STAGE COMPARISONS AND ALUMINUM UPTAKE.
McMaster Univ., Hamilton (Ontario). Dept. of Biology.
J. Freda, and D. G. McDonald.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 210-216, January 1990. 4 fig, 1 tab, 30 ref.

Descriptors: *Acid rain effects, *Aluminum, *Amphibians, *Frogs, *Life history studies, *Toxicity, *Water pollution effects, Bioassay, Hydrogen ion concentration, Lethal limit, Physiology, Stress, Synergistic effects, Tadpoles.

A series of toxicity tests were conducted to investigate the response of embryos, prestage 25 tadpoles, and 3-wk old tadpoles of the leopard frog (Rana pipiens), to a wide range of pH (4.2-4.8) and Al (0-1000 microg/L), and to pH 6.5 with no Al present. In embryos and prestage 25 tadpoles, Al ameliorated the toxic effects of very low pH's (4.2-4.4), while becoming toxic at higher pH's (4.6-4.8). Although both embryos and prestage 25 tadpoles were killed by low pH (pH 4.2-4.4 and 4.2, respectively) and elevated Al (> or = 500 and > or = 250 microg/L Al, respectively), embryos were more sensitive (i.e. higher percent mortality) to low pH, while prestage 25 tadpoles were more sensitive to Al. Three week old tadpoles did not die at any test pH (without Al) and mortality (>20%) caused by Al occurred at only pH 4.8 and 750-1000 microg/L Al. The body sodium concentrations of 3-wk old tadpoles that survived high Al exposure were depressed indicating sublethal stress. Whole body Al uptake in 3-wk old tadpoles was also elevated in water containing high concentrations of Al, but it was positively related to water pH and exposure time. This result suggests that body Al content is not an accurate indicator of Al exposure in tadpoles living in acidic Al contaminated ponds. (Author's abstract)
W90-06123

EFFECT OF INDUSTRIAL WATERS OF FLY-ASH STORAGE FROM A STORAGE YARD OF GRATE WASTES ON ORGANISMS IN WATERS OF THE GDANSK COASTAL REGION (NORTHERN POLAND).
Polish Academy of Sciences, Gdansk. Inst. Budownictwa Wodnego.
I. Kuziemska, B. Quant, and Z. Sulek.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 317-328, 1989. 5 fig, 3 tab, 17 ref.

Descriptors: *Algae, *Fly ash, *Industrial wastewater, *Poland, *Water pollution effects, Aluminum, Calcium, Coasts, Hydroxides, Iron sulfate, Magnesium, Potassium, Sodium.

Industrial waters of fly-ash storage contain soluble components of ash (hydroxides and calcium, sodium, potassium, magnesium, aluminum, and iron sulfates) and trace elements. At doses of 0.1-100 cc per 1 cc of river or sea water or of Guillard-Rychter medium these waters stimulated the primary production of algae. In sea water they primarily stimulated the development of diatoms. (Author's abstract)
W90-06138

CILIATA COMMUNITIES IN THE MIDDLE SECTOR OF THE RIVER LYNA (NORTH-EASTERN POLAND) IN CONDITIONS OF NONPOINT POLLUTION INFLOW.
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Dept. of Water and Wastewater Biology.
M. Hul.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 353-366, 1989. 4 fig, 3 tab, 24 ref.

Descriptors: *Farm wastes, *Nonpoint pollution sources, *Protozoa, *Water pollution effects, Community structure, Microbenthos, Seston.

The reactions of Ciliata communities to rainfall-induced nonpoint pollution runoff from areas of intensive pig farming were analyzed. Structural changes in communities ranged from changes in species composition, the structure of food groups, and saprobity to pronounced changes in the structure of dominance and number of communities. The succession of structural changes corresponded to a rise in the oxidation potential. Seston communities responded to pollution more readily and more dynamically than did those of the microbenthos. (Author's abstract)
W90-06139

ECOLOGICAL STUDIES ON ROTIFERA (ASCHELMINTHES) IN THE RIVER TIGRIS (IRAQ).
Biological Research Center, Baghdad (Iraq). Section of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W90-06140

IMPACT OF COBALT ON THE CARBOHYDRATE METABOLISM OF A FRESHWATER TROPICAL PERCH, COLISA FASCIATUS (BLOCH ET SCHN).
Gorakhpur Univ. (India). Dept. of Zoology.
K. Nath, and N. Kumar.
Acta Hydrobiologica (Cracow) AHBPAX, Vol. 30, No. 3/4, p 429-436, 1989. 2 tab, 54 ref.

Descriptors: *Cobalt, *Fish physiology, *Metabolism, *Toxicology, *Water pollution effects, Lethal limit, Perch, Sublethal effects, Tropical regions.

Median lethal concentrations of cobalt for the teleost fish Colisa fasciatus were computed at 24, 48, 72, and 96 h. The effect of a sublethal concentration of 232.8 ppm (0.8 of LC50 96h) of cobalt on the fishes' carbohydrate metabolism was investigated from 3-96 h. Liver glycogen in the treated fish decreased significantly at 6 h onwards, with a maximum depletion at 72 h. Hyperglycemia was recorded at every exposure interval studied but its peak value was at 72 h. (Author's abstract)
W90-06141

IS FOOD AVAILABILITY THE MAIN FACTOR CONTROLLING THE ABUNDANCE OF EUCHLANIS DILATATA LUCKSIANA HAUER IN A SHALLOW, HYPERTROPHIC LAKE.
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
For primary bibliographic entry see Field 2H.
W90-06142

ROTIFER COMMUNITIES OF ACID-STRESSED LAKES OF MAINE.
Uppsala Univ. (Sweden). Limnologiska Institutionen.
M. T. Brett.
Hydrobiologia HYDRB8, Vol. 186/87, p 181-189, December 1989. 7 tab, 32 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Limnology, *Maine, *Rotifers, Crustaceans, Hydrogen ion concentration, Population dynamics, Trophic level.

The structure of the rotifer community in relation to lake pH, trophic status, the type of planktivore assemblage and the crustacean community was assessed in a survey of 23 lakes ranging in pH from 4.4 to 7.3, and in a study of two lakes--one acidic, the other circumneutral--during two summers. In both investigations the number of rotifer species encountered per sample was strongly reduced with pH. Although the reason for this is not clear, acid-stress, the ultraoligotrophic nature of the acidic lakes, and competitive interactions with crustacean zooplankters may all have played a role. More importantly the ecological significance of this relationship is not known. The rotifer Keratella taurocephala was a principal species in the most acidic lakes, while several common rotifers were notably absent from these lakes. Although rotifer abundance was correlated with lake pH, the results of this study indicate that rotifer abundance is not a result of lake pH per se, but of lake trophic status and interactions with the crustacean community. (Author's abstract)
W90-06149

OCCURRENCE OF ROTIFERA IN THE FIELD UNDER NATURAL AND INTENTIONALLY-CHANGED CONDITIONS: II. LAKE NUMASAWA.
Nihon Univ., Tokyo. Biological Lab.
M. Sudzuki, T. Matsumoto, and K. Narita.
Hydrobiologia HYDRB8, Vol. 186/87, p 247-254, December 1989. 5 fig, 2 tab, 16 ref.

Descriptors: *Lakes, *Limnology, *Rotifers, *Thermal pollution, *Water pollution effects, Cooling water, Electric powerplants, Natural waters, Zooplankton.

Seasonal and vertical occurrences of representative rotifer species were recorded together with Cyanophycea, Phytomastigophorea, Bacillariophycea, Protozoa, Rotifera, and Crustacea, from 1982 to 1986 at two sites in a lake. One site (S1) is natural lake water and the other (S2) is in water that has been recirculated by an electric powerplant in operation since 1952. Keratella hiemalis, Chromogaster ovalis, Notholca labis, Lepadella patella, and Anuraeopsis sp. were observed at S1 and Brachionus urceolaris and Ascomorpha ecaudis at S2. Thus, occurrence of rotifer species seems to be affected by the electric powerplant circulation. Keratella cochlearis, Brachionus calyciflorus, Froalides sp., Diurella sp., Notholca labis, B. urceolaris, and bdelloids did not appear until 1986. The abundance of K. cochlearis in 1986 suggests a beta-oligosaprobic or meso-eutrophic degree of pollution. Asplanchna priodonta herricki and Collotheca sp. have decreased or disappeared since 1982; and Conochiloides coenobasis, Conochilus hippocrepis, and Keratella hiemalis since 1984. A complicated relation was observed between rotifer population density and that of other plankton. For example, P. t. vulgaris occurrence is correlated with Phytomastigophorea but varies inversely with Bacillariophycea; Filinia longiseta abundance is negatively correlated with Bacillariophycea; and A. p. herricki is inversely related to Phytomastigophorea. (Author's abstract)
W90-06155

COMPARATIVE STUDIES ON THE TOXICITY OF PETROLEUM OILS AND THEIR AQUEOUS EXTRACTS TOWARDS ANABAENA DOLIOLUM.
North-Eastern Hill Univ., Shillong (India). Dept. of Botany.
J. P. Gaur, and A. K. Singh.
Proceedings of the Indian Academy of Sciences (Plant Sciences) PIPLDS, Vol. 99, No. 5, p 459-466, October 1989. 3 fig, 2 tab, 30 ref.

Descriptors: *Anabaena, *Oil pollution, *Toxicity, *Water pollution effects, Bioassay, Comparison studies, Growth rates, Petroleum products.

Assam crude, kerosene, petrol, diesel and furnace oil administered into the culture suspension of Anabaena doliolum as whole oil or aqueous extract exerted concentration dependent toxic effects. The hierarchy of toxicity of the test oils was

diesel>furnace oil>petrol>kerosene>crude. The oils rich in aromatics were most toxic and therefore estimation of this fraction might enable prediction of toxicity of an oil. Growth rate was a more sensitive criterion of oil toxicity as compared of final standing crop. In case of crude and kerosene, the whole oil application was more inhibitory than their respective aqueous extracts, whereas reverse trend was obtained in case of other oils. Toxicological evaluation of whole oils as well as their aqueous extracts is recommended for meaningful results. (Author's abstract)
W90-06157

HEALTH RISK ASSESSMENT OF 1,1,2-TRICHLOROETHANE (1,1,2-TCA) IN CALIFORNIA DRINKING WATER.
California Univ., Davis. Dept. of Environmental Toxicology.
N. R. Reed, W. Reed, L. Beltran, R. Babapour, and D. P. H. Hsieh.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-131999. Price codes: A04 in paper copy, A01 in microfiche. Report No. UCD/ET-88/2, November 2, 1988. 87p, 5 fig, 16 tab, append.

Descriptors: *California, *Chlorinated hydrocarbons, *Drinking water, *Trichloroethane, *Water pollution effects, Bioassay, Biological studies, Path of pollutants, Public health, Toxicity.

1,1,2-Trichloroethane (1,1,2-TCA) is used mainly as a chemical intermediate in the manufacture of 1,1-dichloroethylene. It is also used as a solvent in industry. 1,1,2-TCA is a colorless volatile liquid and it has a pleasant odor. In California, it was detected in 4 of 2,949 wells in large water systems, at concentrations ranging from 0.70 to 1.10 micrograms/L (ug/L). A model that considers the ingestion, dermal, and inhalation routes of exposure associated with the use of 1,1,2-TCA contaminated drinking water is used in the estimation of human exposure. The estimated contribution of each route of exposure is approximately one third of the total exposure. In California, an estimated population of 5,861 is receiving an average lifetime daily dose of 9,770,000 mg/kg/day 1,1,2-TCA. The toxic effects of 1,1,2-TCA in animals include decreases in fluid intake and weight gain, impairment of liver and kidney functions, hepatic and renal necrosis, central nervous system depression, irritation of the skin, eyes and mucous membranes, and hematological and immunological alterations. No reproductive or developmental toxicity associated with 1,1,2-TCA exposure has been reported. 1,1,2-TCA is not mutagenic in the Ames Salmonella/microsome assay. No case reports or epidemiological studies concerning the effects of 1,1,2-TCA in humans have been found. 1,1,2-TCA is a narcotic as well as an irritant to the eyes, skin, and respiratory tract. No information on the mutagenicity or carcinogenicity of 1,1,2-TCA in humans is available. (Lantz-PTT)
W90-06169

HEALTH RISK ASSESSMENT OF 1,2-DICHLOROPROPANE (1,2-DCP) IN CALIFORNIA DRINKING WATER.
California Univ., Davis. Dept. of Environmental Toxicology.
N. R. Reed, W. Reed, L. Beltran, R. Babapour, and D. P. H. Hsieh.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-132005. Price codes: A04 in paper copy, A01 in microfiche. Report No. UCD/ET-88/3, November 18, 1988. 76p, 4 fig, 14 tab.

Descriptors: *California, *Chlorinated hydrocarbons, *Dichloropropane, *Drinking water, *Water pollution effects, Bioassay, Biological studies, Path of pollutants, Public health, Toxicity.

1,2-Dichloropropane (1,2-DCP) is an intermediate in the production of tetrachloroethylene. It is used as a solvent, a nematocidal soil fumigant, and in the regeneration of petroleum catalyst. 1,2-DCP is a colorless liquid with a chloroform-like odor. In California, it was detected in 4 of 2,949 wells in large water systems, at concentrations ranging from 0.70 to 1.37 micrograms/L. A model that considers the ingestion, dermal, and inhalation routes of exposure associated with the use of 1,2-DCP contaminated drinking water is used in the estimation of human exposure. The estimated contribution of each route of exposure is approximately one third of the total exposure. An estimated population of 4,948 is receiving an average lifetime daily dose of 9.48 ng/kg/day of 1,2-DCP. The toxic effects of 1,2-DCP in animals include lethargy, reduction in body weight gain, hepatic, renal, and adrenal lesions and degeneration, impairment of liver function, pulmonary congestion, olfactory degeneration, hemosiderosis of the spleen, eye irritation and central nervous system depression. No epidemiological studies on the effects of 1,2-DCP in humans are available. Information from case reports indicated that the following effects are associated with exposure to 1,2-DCP; liver and kidney dysfunction, skin and eye irritation, narcosis, hemolytic anemia, and cardiac failure. No information on the possible reproductive, teratogenic, mutagenic, or carcinogenic effects in humans was found in the available literature. (Lantz-PTT)
W90-06170

ENVIRONMENTAL EFFECTS AND FATE OF DECONTAMINATION AGENT C-8 IN SOIL.
Argonne National Lab., IL. Energy and Environmental Systems Div.
S. D. Zellmer, W. A. Mego, and R. R. Hinchman.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-016445. Price codes: A03 in paper copy, A01 in microfiche. Report No. ANL/EES TM--350, December 1987. 40p, 17 fig, 5 tab, 13 ref, append.

Descriptors: *Agent C-8, *Decontamination, *Fate of pollutants, *Groundwater pollution, *Path of pollutants, *Water pollution effects, Calcium hypochlorite, Chemical analysis, Chlorinated hydrocarbons, Environmental effects, Simulation analysis, Soil bacteria, Soil contamination, Soil fungi, Tetrachloroethylene.

Agent C-8 is a new Army decontamination agent designed to deactivate and remove chemical and biological warfare agents from vehicles and equipment. Its active ingredients are tetrachloroethylene (designated as a priority pollutant by the US EPA) and calcium hypochlorite (a source of free chlorine). This laboratory study focused on the environmental fate of C-8 constituents in the soil ecosystem; the soil transport characteristics of, and potential for groundwater contamination by, tetrachloroethylene; and the effects of C-8 constituents on soil microorganisms. Four scenarios were developed to simulate most actual C-8 spills in the field. Soil columns in glass cylinders simulated the upper portion of a typical soil profile. Effluents and soils from each column were analyzed by gas chromatography to determine tetrachloroethylene concentrations. An identical set of soil samples was screened for effects on various groups of soil microorganisms. When tetrachloroethylene in C-8 enters the soil, it appears to be sorbed in certain profile regions and its movement is retarded with respect to that of water. This bound tetrachloroethylene appears to leach out of the soil profile over a long time, moving down toward groundwater at concentrations that are low (about 10 parts per million) compared with those originally applied to or retained in the soil. Effects on soil biota depend on physiological differences among species. Soil fungi appear to be affected most adversely, while some bacterial groups are unaffected by exposure to C-8 and others are enhanced. (Author's abstract)
W90-06173

FISH COMMUNITIES IN LAKES IN SUBREGION 2B (UPPER PENINSULA OF MICHIGAN) IN RELATION TO LAKE ACIDITY. VOLUME I.
Northrop Services, Inc., Corvallis, OR.
For primary bibliographic entry see Field 2H.
W90-06181

COMPARATIVE HEALTH EFFECTS ASSESSMENT OF DRINKING WATER TREATMENT TECHNOLOGIES: REPORT TO CONGRESS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-175710. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA 570/9-88/009, November 1988. 200p, 12 fig, 41 tab, 203 ref.

Descriptors: *Drinking water, *Public health, *Water pollution effects, *Water treatment, Chemical treatment, Chlorination, Disinfection, Organic compounds, Pathogens, Pesticides, Physical treatment, Tetrachloroethylene, Toxicity, Trichloroethylene.

Commonly used drinking water treatment processes, including disinfection, filtration, and other processes designed to remove chemical and physical contaminants, provide enormous benefits in ensuring the quality and safety of drinking water in the United States. This report focuses on the risks of disinfection and its by-products because it is the most widespread treatment technique employed on a national basis. The public is generally exposed to disinfection by-products, almost exclusively from drinking water, throughout their lifetime. Pathogenic microorganisms continue to be the major cause of waterborne disease outbreaks in the United States. Raw water quality is highly variable in its content of microbes, organic substances, inorganic compounds, and radionuclides. Since pathogens clearly exist in many raw waters, disinfection and/or other technologies designed to remove them should be used by those water systems with contaminated water to ensure protection against significant public health risks. To date, analytical surveys have discovered a number of organic byproducts of chlorination, including chloroform, dichloroacetic and trichloroacetic acids, trichloroacetaldehyde, and bromodichloromethane. Other disinfectants have been less extensively studied than chlorine. On the other hand, chlorine, chlorine dioxide, and monochloramines, and other byproducts of chlorine dioxide, show some evidence of toxicity at high doses. Another health concern is the low level contamination of drinking water by industrial solvents, such as trichloroethylene and tetrachloroethylene. Granular activated carbon and air stripping are effective treatment technologies for these organic compounds. (Lantz-PTT)
W90-06195

FISH COMMUNITIES IN LAKES IN SUBREGION 2B (UPPER PENINSULA OF MICHIGAN) IN RELATION TO LAKE ACIDITY. VOLUME II: APPENDICES.
Northrop Services, Inc., Corvallis, OR.
For primary bibliographic entry see Field 5B.
W90-06215

WATER QUALITY OF THE LEXINGTON RESERVOIR, SANTA CLARA COUNTY, CALIFORNIA, 1978-80.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2H.
W90-06221

WATER RESOURCES OF VILAS COUNTY, WISCONSIN.
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06224

DETERMINATION OF THE TOXICITY, WATER QUALITY INTERACTIONS AND BIOMAGNIFICATION OF SELENIUM IN AQUATIC FOOD CHAINS.
California Univ., Davis. Dept. of Land, Air and Water Resources.
K. J. Maier, R. S. Ogle, K. A. R. Maier, M. J. Williams, and D. Malchow.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-132648/

AS. Price codes: A07 in paper copy, A01 in microfiche. Final Technical Report, Aug. 1989. 126p, 8 fig, 27 tab, 215 ref. USGS Contract 14-08-0001-G1495.

Descriptors: *Bioaccumulation, *Food chains, *Selenium, *Toxicity, Algal primary producers, Anabaena flos-aquae, Aquatic life, Bluegills, Daphnia, Diptera, Ecosystems, Fathead minnows, Hyalella azteca, Selenastrum capricornutums, Water pollution effects, Water quality.

Ecological degradation of aquatic ecosystems associated with the presence of elevated concentrations of the trace element selenium has been of considerable scientific, governmental and public concern. The increased flux of selenium into several aquatic ecosystems, due to anthropogenic activities, has resulted in death, teratogenesis, reproductive impairment and decreased populations in fish and waterfowl communities in these systems. Research is continuing on several investigations into the toxicity, bioaccumulation, transfer and biotransformation of selenium in aquatic organisms and laboratory food chains. Initial studies were primarily concerned with the comparative acute and chronic toxicity, water quality interactions, and toxicological interactions of several chemical species of selenium to a variety of aquatic organisms including two algal primary producers (Selenastrum capricornutum and Anabaena flos-aquae), three invertebrate primary consumers (Daphnia magna, chironomus decorus, and Hyalella azteca), and a fish (Pimephales promelas). Further research was directed towards the biotransformation, transfer, and subsequent bioaccumulation of selenium in simplified laboratory aquatic food chains. Studies on the transfer, bioaccumulation and toxicity of selenium from dietary sources (algal primary producer: Selenastrum Capricornutum) to consumers (aquatic invertebrates: Daphnia magna and Chironomus decorus) were conducted. The development of a methodology for determining and quantifying the biochemical speciation of selenium in aquatic organisms was initiated, as was a study examining the comparative accumulation of waterborne selenium by bluegill (Lepomis macrochirus) and fathead minnows (Pimiphales promelas). (USGS)
W90-06236

5D. Waste Treatment Processes

HYDRAULIC MODEL OF OVERLAND FLOW ON GRASS COVERED SLOPES.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05683

WOOD-DEGRADING FUNGI AS DEGRADERS OF HAZARDOUS WASTE.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
For primary bibliographic entry see Field 5G.
W90-05731

RETENTION, DETENTION, AND OVERLAND FLOW FOR POLLUTANT REMOVAL FROM HIGHWAY STORMWATER RUNOFF: INTERIM GUIDELINES FOR MANAGEMENT MEASURES.
Versar, Inc., Springfield, VA.
M. E. Dorman, J. Hartigan, F. Johnson, and B. Maestri.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-133292. Price codes: A10 in paper copy, A01 in microfiche. Report No. FHWA/RD-87/056, March 1988. 189p, 48 fig, 12 tab, 37 ref, append. Federal Highway Administration Contract DTFH6a-85-C-00117.

Descriptors: *Water pollution treatment, *Highways, *Storm runoff, *Management planning, Vegetation, Detention basins, Wells, Wetlands, Standards.

Three general types of management measures have been determined, through previous Federal Highway Administration studies, to be effective in treating highway runoff: vegetative controls (overland flow and grassed channels), detention basins (wet detention basins and wetlands), and retention measures (retention basins, trenches and wells). These interim design guidelines have been developed based on experience of the project team and by a thorough review of available literature. Field and laboratory studies are currently underway to verify the design procedures and assumptions presented in this report. (Author's abstract)
W90-05754

TREATMENT OF CHROMIUM CONTAMINATED PLATING SHOP RINSEWATER STREAMS BY REVERSE OSMOSIS.
Oak Ridge National Lab., TN.
J. F. Walker, C. H. Brown, and J. H. Wilson.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-014565. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-881003--1, 1988. 14p, 8 fig, 3 tab, 1 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Chromium, *Metal-finishing wastes, *Reverse osmosis, *Wastewater treatment, Evaporation, Wash water.

A characterization study of the effluent from the plating shop indicated that the effluent contained chromium concentrations which were at times in violation of the permit discharge limits. Several improvements in the operation of the plating shop were implemented which reduced the quantity of chromium in the effluent by as much as 85%. The use of reverse osmosis (RO) and evaporation were recommended, to meet the sponsors objective for the demonstration of innovative wastewater treatment technology. This technique would be applied to the two remaining major sources of chromium contamination (the gun line rinse and the bright dip rinse). Pilot scale RO tests indicate that the gun line rinse waters can be successfully treated by RO. Further tests are being conducted on the bright dip rinse waters to determine the best pretreatment scheme. The installation of a full-scale treatment system is dependent on the successful completion of pilot studies currently being conducted. (Lantz-PTT)
W90-05787

SEPTIC TANK ABSORPTION SYSTEMS: A LITERATURE REVIEW.
National Building Research Inst., Pretoria (South Africa).
D. C. de Villiers.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-167233. Price codes: E05 in paper copy, E05 in microfiche. Report No. CSIR-BOU-78, 1987. 36p, 9 fig, 11 tab, 119 ref.

Descriptors: *Literature review, *Septic tanks, *South Africa, *Wastewater disposal, *Wastewater treatment, Domestic wastes, Waste disposal.

From the literature, it is clear that a septic tank absorption field can have a considerable life expectancy when properly designed, constructed and maintained. The US disposes of one-third of its liquid domestic waste by way of subsurface absorption fields. An absorption field can therefore be a worthy alternative to reticulated sewerage and not just a second-class option or last resort. A review of overseas research on field absorption systems is presented along with speculation on the applicability of the results in South Africa. In general, subsurface absorption systems appear to be an acceptable and safe method for disposal of effluent, provided that the systems are properly designed, sited, constructed and maintained. Up to now, the South African authorities have scarcely ensured that septic tank absorption systems function as intended or that they are properly maintained. (Author's abstract)
W90-05791

MANAGEMENT OF EFFLUENTS/BY-PRODUCTS OF MULTI-PURPOSE FINE CHEMICAL MANUFACTURE.
Imperial Chemical Industries Ltd., Manchester (England). Organics Div.
H. M. Donaldson.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 509-523, 3 fig, 4 ref.

Descriptors: *Chemical industry, *Risk assessment, *Wastewater management, *Wastewater treatment, *Water pollution control, Chemical wastewater, Design standards, Management planning, Monitoring, Policy making.

In the 19th century, public concerns over hydrochloric acid pollution from the alkali industry led directly to the passing of the Alkali Act of 1863. This was the first effective environmental protection Act, eventually encompassing much of the chemical industry and establishing the Alkali Inspectorate as an enforcement authority. Over the years there has been an increase in the complexity and sophistication of chemical processes and manufacturing plants. This has been reflected in the nature of the effluents from such processes and the problems of disposal. Such problems are particularly acute in multi-purpose fine chemicals plants. It is important to differentiate between those units, typical of either petrochemical, commodity or specialty chemical manufacture, which are designed with a high degree of specificity for a single product or small group of products and a multi-purpose fine chemicals plant. Three plant types and effluents (olefins; biocides unit; and intermediates plant) are used as examples of single and batch operations for wastewater streams. Management of the more common, multi-purpose (batch) fine chemical sites requires: (1) development of a management policy; (2) site organization; (3) site systems policy; (4) site hardware policy; (5) procedures and management systems--the design of plants and processes, design information, working procedures, start-up of new plants, and work general orders; (6) training; and (7) monitoring and auditing. (See also W90-05792) (Lantz-PTT)
W90-05802

GROWTH AND BIOCATALYTIC ACTIVITIES OF AEROBIC THERMOPHILIC POPULATIONS IN SEWAGE SLUDGE.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Dept. of Biotechnology.
M. Bomio, B. Sonnleitner, and A. Fiechter.
Applied Microbiology and Biotechnology AMBIDG, Vol. 32, No. 3, p 356-362, 1989. 5 fig, 1 tab, 20 ref.

Descriptors: *Aerobic treatment, *Biological wastewater treatment, *Enzymes, *Microbial degradation, *Sludge treatment, *Wastewater treatment, Carbon, Oxygen, Proteolytic activity, Temperature.

Enzymatic activities of aerobic thermophilic microorganisms are described and investigated for the development and control of sewage sludge treatment processes in batch and fed-batch cultures. Proteolytic activity is the main enzymatic activity in an aerobic thermophilic sewage sludge treatment process. It has an optimum activity at 80 C and can be found also during growth on synthetic media. The activity is correlated with the increase in ammonium in the particle-free fraction and the values of the respiratory quotients during cultivation either in sewage sludge or in a synthetic medium. No other extracellular activities (lipase, amylase, pectinase and cellulase) were detected in the investigated sludge samples. Carbohydrates, lipids and other polymers were either not present in significant amounts or passed with only minor modifications through the treatment. Cultures in sewage sludge were either oxygen or carbon limited. One strain able to excrete lysozyme was isolated. It might have a synergistic effect on the heat inactivation of pathogenic microorganisms (cryptic growth) although lytic activity remained very low. Two-thirds of the entire metabolic activity is due to degradation of insoluble matter. The utilization of particulate matter also has a positive influence on the efficiency of the process by reduction in dry matter and increase in water removal properties. Even at extremely low aeration rates, the acidifica-

tion effect was small. Only small amounts of isobutyrate, isovaleriate and 2-methylbutyrate were formed at extremely low aeration rates and caused an increase in the total volatile fatty acid content after 12 and 36 h culture time. (Author's abstract)
W90-05857

VARIABLE MORPHOLOGY IN CERTAIN FILAMENTOUS BACTERIA AND THE IMPLICATIONS OF THIS FOR THEORIES OF ACTIVATED SLUDGE BULKING.

Leeds Univ. (England). Dept. of Civil Engineering.
A. M. Buali, and N. J. Horan.
Environmental Technology Letters ETLEDB, Vol. 10, No. 11, p 941-950, November 1989. 4 fig, 4 tab, 2 pl, 21 ref.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Bulking sludge, *Wastewater treatment, Fast-feed control strategy, Filamentous bacteria.

Many activated sludges are subjected to a rapid proliferation of filamentous bacteria leading to a bulking sludge. This phenomenon often occurs in 24 hr or less and these same sludges appear able to eliminate the filamentous bacteria in an equally short time period. Two causative filamentous bacteria have been characterized and grown under a range of feed-fast regimes. The imposition of a fasting phase caused morphological changes in the filaments with an ultimate breakdown to individual cells. The results suggest the possibility of a fast/feed control strategy based on the identification of the predominant filament type. (Author's abstract)
W90-05868

EFFECT OF TRANSIENT LOADING, PH AND TEMPERATURE SHOCKS ON ANAEROBIC FILTERS AND FLUIDISED BEDS.

Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
S. M. Cayless, D. M. L. da Motta Marques, and J. N. Lester.
Environmental Technology Letters ETLEDB, Vol. 10, No. 11, p 951-968, November 1989. 9 fig, 4 tab, 20 ref.

Descriptors: *Anaerobic digestion, *Chemical oxygen demand, *Food-processing wastes, *Organic wastes, *Wastewater treatment, Alkalinity, Filters, Fluidized beds, Hydrogen ion concentration, Methane, Suspended solids, Temperature, Volatile acids.

Two anaerobic filters, two fluidized beds and a two-phase anaerobic system consisting of a continuously-stirred tank reactor acidogenic phase and a fluidized bed methanogenic phase, operating at mesophilic temperatures on an influent of ice-cream factory production waste, were subjected to quantitative increases of chemical oxygen demand (COD) loading under varying conditions for 8 hour periods. Methane production and effluent suspended solids, total volatile acids, and alkalinity levels increased but percent COD removals decreased during the shock periods. However, most operational parameters had returned to pre-shock levels by 24h. Variations in operating temperature and COD/influent pH were also applied. Eight hour reductions to ambient temperature were tolerated well in both filters and fluidized beds but low influent pH levels coupled with increased loading produced a permanent shift in reactor operational parameters and were considered inadvisable. (Author's abstract)
W90-05869

EFFECTS OF SONICATION ON ACTIVATED SLUDGE.

Birmingham Univ. (England). Dept. of Chemical Engineering.
R. O. King, and C. F. Forster.
Enzyme and Microbial Technology EMTED2, Vol. 12, No. 2, p 109-115, Feb 1990. 9 fig, 17 ref.

Descriptors: *Activated sludge process, *Flocculation, *Ultrasonics, *Wastewater treatment, Biopolymers, Carbohydrates, Filtration, Proteins, Shear, Sludge.

Sonication with power levels of 7.5-75 watt-minutes caused disruption of the sludge flocs which increased with the intensity of the power. This caused the filtration characteristics and the quality of the sludge supernatant to deteriorate. There was a clear relationship between the mean particle size and the sonic power, a relationship that could be used to derive values for the floc for the strength. Sonication also released soluble carbohydrate and protein from the sludge. The way in which this release occurred in the presence of a high-molecular-weight cationic polyelectrolyte suggests that there was a sequential release of different biopolymers from the sludge as the power was increased. Since there are many places in an activated sludge plant where flocs are subjected to shear, the regular determination of floc strength might provide a useful operational tool. (Author's abstract)
W90-05872

INFLUENCE OF NITROGEN SUPPLY RATES ON GROWTH AND NUTRIENT STORAGE BY WATER HYACINTH (EICHHORNIA CRASSIPES) PLANTS.

Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 2H.
W90-05895

EXPERT SYSTEM SURVEY ON BIODEGRADATION OF XENOBIOTIC CHEMICALS.

Environmental Protection Agency, Washington, DC. Office of Toxic Substances.
For primary bibliographic entry see Field 5B.
W90-05941

NITROSOMONAS AND NITROBACTER INTERACTIONS IN BIOLOGICAL NITRIFICATION.

Illinois State Water Survey Div., Champaign.
C. S. Gee, J. T. Pfeffer, and M. T. Suidan.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 4-17, January/February 1990. 9 fig, 5 tab, 9 ref. U.S. Department of Energy Grant No. DE-AC21-82MC19352.

Descriptors: *Ammonia, *Denitrification, *Nitrification, *Nitrites, *Nitrogen fixing bacteria, *Wastewater treatment, Limiting nutrients, Nitrates, Oxidation, Population dynamics, Retention time.

The biological oxidation of ammonia to nitrate occurs in two distinct oxidation steps; ammonia is oxidized to nitrite by Nitrosomonas and nitrite is then oxidized to nitrate by Nitrobacter. To better understand this two-step process, biological-nitrification experiments were performed in chemostats with three different nitrogenous substrates: ammonia, nitrate, and various mixtures of ammonia and nitrite. The interrelationship between two groups of nitrifying bacteria (Nitrosomonas and Nitrobacter) was studied using different substrates within the same environment. Continuous-feed ammonia or nitrate experiments were conducted at a pH of 8.0 at room temperature (23 C) for various hydraulic retention times in the chemostats. The nitrogen species were analyzed according to Standard Methods for the Examinations of Water and Wastewater. Effects on bacteria population dynamics were plotted as a function of ammonia and nitrite concentrations. The activity of the Nitrobacter population was strongly dependent on the population of Nitrosomonas, but not vice versa. Nitrite oxidation in the absence of ammonia resulted in a very unstable system and required hydraulic-retention times of 10 days or greater to obtain complete nitrite oxidation. This was in sharp contrast to the complete oxidation of ammonia to nitrate at the hydraulic-retention time of 2.7 days. The specific activity of the Nitrobacter population was reduced to about one-third of the optimum activity when the Nitrosomonas population was one-tenth of its maximum density. (Geiger-PTT)
W90-05953

MODELING OF NITRIFICATION UNDER SUBSTRATE-INHIBITING CONDITIONS.

Illinois State Water Survey Div., Champaign.
C. S. Gee, M. T. Suidan, and J. T. Pfeffer.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 18-31, January/February 1990. 6 fig, 1 tab, 15 ref. U.S. Department of Energy Grant DE-AC21-82MC19352.

Descriptors: *Ammonia, *Biological wastewater treatment, *Nitrification, *Nitrites, *Oxidation, *Wastewater treatment, Mathematical models, Model studies, Nitrates, Regression analysis.

A mathematical model was developed for the biological-nitrification process. The model assumed two consecutive oxidation steps occurring under a substrate-inhibiting condition. The mathematical model was calibrated using data obtained from batch experiments performed on the contents of five chemostats operated to steady-state on a feed containing 1,000 milligrams/L of ammonia-nitrogen. In the batch experiments, initial ammonia concentrations ranging from 100 to 1,000 milligrams N/L were used. Time-varying concentrations of ammonia and nitrite were collected until the oxidation of these constituents was complete. Parameter sets that optimized the fit on the mathematical model to the experimental data were obtained by nonlinear-regression analyses. The oxidation of ammonia to nitrite was well represented by the Haldane-inhibition model. The Haldane-inhibition model did not satisfactorily describe the oxidation of nitrite to nitrate. It was observed that the simultaneous presence of both nitrite and ammonia led to the inhibition of nitrite oxidation. Modification of the model to consider a revised inhibition mechanism that accounted for the observed behavior was quite successful for the interpretation of the nitrite-oxidation data. (Author's abstract)
W90-05954

SENSITIVITY ANALYSES OF BIODEGRADATION/ADSORPTION MODELS.

Texas Univ., Austin. Dept. of Civil Engineering.
G. E. Speitel, and X. J. Zhu.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 32-48, January/February 1990. 11 fig, 2 tab, 14 ref, append.

Descriptors: *Activated carbon, *Adsorption, *Biodegradation, *Biofilms, *Sensitivity analysis, *Wastewater treatment, *Water treatment, Biological wastewater treatment, Biomass, Mathematical models, Microbiological studies, Organic compounds, Sorption.

Mathematical models of simultaneous adsorption and biodegradation in granular activated carbon (GAC) columns used in the treatment of low concentrations of synthetic organic chemicals were developed and refined. The sensitivity of models to individual parameters was investigated, along with alternative formulations for mass transport resistances within the biofilm and at the biofilm/GAC interface. The sensitivity analyses identified three important parameters: the Monod half-saturation coefficient, the GAC surface diffusion coefficient, and the amount of biomass initially attached to the GAC. Small values of the half-saturation coefficient, which are characteristic of oligotrophic microorganisms, were required to simulate the entire range of experimental data. Models with and without a diffusive transport resistance through a biofilm matched the experimental data well. The substrate concentration, however, was quite low, and biofilm diffusion probably would be important at somewhat higher concentrations. A model having a transport resistance at the biofilm/GAC interface did not perform well, implying that sorbed substrate is readily available to microorganisms even under conditions that select for scattered growth of microorganisms on the GAC surface. (Author's abstract)
W90-05955

FIXED-FILM BIOMETHANATION MODELING.

Western India Industries, Poona (India).
A. P. Annachhatre, and P. Khanna.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 49-69, January/

February 1990. 11 fig, 3 tab, 28 ref.

Descriptors: *Biofilm reactors, *Mathematical models, *Methylation, *Wastewater treatment, *Water hyacinth, Graphical analysis, Kinetics, Mass transport, Retention time.

A biofilm model incorporating diffusive mass transport and Monod kinetics to represent substrate uptake by biofilm during its growth phase, is developed, calibrated, verified, and used for estimation of minimum hydraulic-retention time (HRT) with respect to biomethanation of water hyacinth through fixed-film-reactor technology. The results have been compared with those obtained through Young's Model, which incorporates the concept of effective substrate concentration in the biofilm. A graphical procedure is also developed for estimation of minimum steady-state HRT. The variations between predicted values and experimental observations have been attributed to substrate multiplicity in real-life situations and the need for simplistic modeling approaches as an aid to design. The procedures presented in this paper could be employed for design of fixed-film-reactor systems for biomethanation of any substrate. (Author's abstract)
W90-05956

AERATION-BASIN HEAT LOSS.
Braun (C.F.) and Co., Alhambra, CA.
S. N. Talati, and M. K. Stenstrom.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 70-86, January/February 1990. 6 fig, 5 tab, 17 ref.

Descriptors: *Aeration, *Aerators, *Heat transfer, *Temperature effects, *Wastewater treatment, Computer models, Design criteria, Humidity, Radiation, Wind velocity.

When choosing aeration systems for wastewater treatment, potential effects of recent designs on aeration basin temperature should be evaluated. To predict aeration-basin temperature and its effect on system design, previous research was surveyed and a spreadsheet-based computer model was developed. The equilibrium temperature predicted in the model is obtained from a heat balance around the aeration basin. Various components of heat transfer in the aeration basin are identified, quantified, and arranged for estimating equilibrium aeration basin temperature. The model is applicable to a completely mixed basin under steady-state conditions. Calculations were improved significantly in the areas of heat loss from evaporation due to aeration and atmospheric radiation. The model was verified with 17 literature-data sets, and predicted temperature with a root-mean-squared error of 1.24 C for these sets. The model can be used to predict aeration basin temperature for plants at different geographical locations with varying meteorological conditions for surface, subsurface, and high-purity aeration systems. The major heat loss is through evaporation from aeration, accounting for as much as 50%. Heat loss from surface aerators can be twice that of an equivalent subsurface system. Wind speed and ambient humidity are important parameters in determining aeration-basin temperature. (Geiger-PTT)
W90-05957

AZO DYE OZONATION FILM THEORY UTILIZATION FOR KINETIC STUDIES.
Universidad Complutense de Madrid (Spain). Dept. de Ingenieria Quimica.
J. L. Sotelo, F. J. Beltran, J. Beltran-Heredia, and J. M. Encinar.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 4, p 391-409, 1989. 6 fig, 8 tab, 16 ref, append, Comision Asesora de Investigacion Cientifica y Technica Grant 1109/81..

Descriptors: *Azo dyes, *Organic matter, *Ozonation, *Water treatment, Absorption, Kinetics, Model studies.

The ozonation kinetics of three azo dyes (Direct Yellow 27, Direct Blue 1 and Acid Black 52) in aqueous solution has been studied. Two types of reactors have been used, an agitated tank for studying the influence of variables and the stoichiometry, and an agitated cell for kinetic measurements. Both the film theory and the modes of ozone action on organic matter have been considered for obtaining the kinetic rate constants. A model of ozone absorption in the fast pseudo-m-th ozone order kinetic regime with two parallel reactions fits satisfactorily the experimental results. From the model the kinetic constants of both reactions have been evaluated. The three dyes were depleted by ozone either by electrophilic attack (direct reaction) or by non-selective action of the hydroxyl free radical generated by ozone decomposition. The non-selective action of the hydroxyl free radical generated by ozone decomposition has little effect or no significance in the case of Direct Blue 1. Overall first order reactions for each dye, and 0.5 order (in ozonation of Direct Yellow 27 and Acid Black 52) and 0 order (in the case of Direct Blue 1) for ozone, have been deduced. Two parallel reactions of (1,1) dye and ozone kinetic orders (direct pathway) and (1,0) orders (radical pathway), deduced from a mechanism, explain this behavior. (Geiger-PTT)
W90-05974

RUNNING LIFT STATIONS VIA TELEMETRY.
M. Entus.
Water Engineering and Management WENMD2, Vol. 137, No. 11, p 41-42, November 1989. 1 fig.

Descriptors: *Control systems, *Pumping plants, *Remote sensing, *Telemetry, *Utilities, *Wastewater management, *Wastewater treatment, Florida, Monitoring, Wastewater facilities.

Daily operations are continuously tracked for critical alarm situations via telemetric monitoring for 111 wastewater pumping stations in Plantation, Florida. The 24-hour monitoring provides Plantation personnel the ability to take care of critical problems such as malfunction of pumps or power failures (possibly resulting in sewage back-up in homes or raw sewage spills) before they endanger the health and safety of community residents. A printer records each alarm including location, type of alarm, date, time of day, and a summary of the activity. An operator checks the data and makes decisions about changes in the status of the stations. Printed readouts are tuned in to the city on a weekly basis to be analyzed by the utilities departments. Saving over conventional monitoring stations in which a station checker checked each station once each every 24 hours, averages 13.54 percent. (Chonka-PTT)
W90-06033

CADMIUM UPTAKE AND TOXICITY TO WATER HYACINTH: EFFECT OF REPEATED EXPOSURES UNDER CONTROLLED CONDITIONS.
Tel-Aviv Univ. (Israel). Inst. for Nature Preservation Research.
R. Nir, A. Gasith, and A. S. Perry.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 149-157, January 1990. 5 fig, 4 tab, 20 ref.

Descriptors: *Bioaccumulation, *Biological wastewater treatment, *Cadmium, *Toxicity, *Wastewater treatment, *Water hyacinth, Aquatic plants, Biomass, Plant growth, Plant tissues, Tissue analysis, Water pollution treatment.

Water hyacinth, Eichornia crassipes (Mart) Solms, has drawn attention as a plant of rapid growth and high biomass production, with the capability of removing pollutants from domestic and industrial waste effluents. This study was undertaken to evaluate the potential capacity of water hyacinth to remove Cd from solution under conditions of repeated exposures but otherwise favorable growth conditions, and without interference from other toxic compounds. Plants were repeatedly exposed to 0, 0.1, 0.5, 1, or 2.5 mg Cd/L by replacing the medium once a week following flushing of the test buckets with tap water. Exposure of water hyacinth to Cd in concentrations greater than 0.1 ppm resulted in accumulation of Cd in roots and leaves, chlorosis of the cleaves and suppression of plant growth. No trace of Cd was found in unexposed plants, and the Cd concentration in roots and leaves of exposed plants was positively correlated with the Cd concentration in solution ($r > 0.9$) and to the time of exposure (up to 3 weeks, $r > 0.9$). Maximum Cd concentration in plants exposed to 0.4 ppm for 3 weeks was found in the roots (703 and 67 ppm in the roots and leaves, respectively). The data also revealed about 30% reduction in the Cd removed per week, after one week of exposure. The new gain of wet biomass was negatively correlated with the Cd concentration in the medium and the period of exposure. A 50% reduction in plant growth and chlorosis of the leaves was recorded in plants exposed to 0.4 ppm Cd within the first week, while at the lower concentration of 0.1 ppm an effect was noticeable after three weeks. Under favorable nutrient conditions and interference from no other toxic metals, water hyacinth has been shown to have a remarkable capacity for removing Cd from solution (> 70%), under conditions of repeated exposure to relatively low concentrations of the metal (< 0.5 ppm). (VerNooy-PTT)
W90-06042

MICROBIAL OXIDATION OF CRUDE OIL HYDROCARBONS IN DANUBE WATER.
Slovenska Akademia Vied, Bratislava (Czechoslovakia). Ustav Experimentalenj Biologie a Ekologie.
For primary bibliographic entry see Field 5B.
W90-06059

GENOSPECIES DIVERSITY OF ACINETOBACTER ISOLATES OBTAINED FROM A BIOLOGICAL NUTRIENT REMOVAL PILOT PLANT OF A MODIFIED UCT CONFIGURATION.
Bendigo Coll. of Advanced Education (Australia). Dept. of Biological and Chemical Sciences.
A. M. Beacham, R. J. Seviour, K. C. Lindrea, and I. Livingston.
Water Research WATRAG, Vol. 24, No. 1, p 23-29, January 1990. 6 fig, 3 tab, 25 ref.

Descriptors: *Acinetobacter, *Biological studies, *Microbiological studies, *Phosphorus removal, *Species diversity, *Wastewater treatment, Aerobic digestion, Anaerobic digestion.

Isolates of Acinetobacter obtained from all stages of a wastewater phosphorus-removal pilot plant over a 14 month periods were characterized and classified into the genospecies of Bouvet and Grimont. The pilot plant used in this study, based on the modified University of Cape Town configuration, had a total operating volume of 120 L and a mean biomass retention time of 25 days. It consisted of three anaerobic, four anoxic and five aerobic reactors in sequence, but with recycling. Sludge samples were removed from each reactor stage at approximately monthly intervals, over a 14 month period. Both freely dispersed and clustered cells were studied. The plant contained a very diverse Acinetobacter population with only A. haemolyticus (genospecies 4) and A. calcoaceticus (genospecies 1) not found. The dominant recovered isolate was A. junii (genospecies 5), and ability to cluster was not associated with a single genospecies. (Schidler-PTT)
W90-06068

REMOVAL OF CHROME DYE FROM AQUEOUS SOLUTIONS BY MIXED ADSORBENTS: FLY ASH AND COAL.
Banaras Hindu Univ., Varanasi (India). Inst. of Tech.
G. S. Gupta, G. Prasad, and V. N. Singh.
Water Research WATRAG, Vol. 24, No. 1, p 45-50, January 1990. 6 fig, 5 tab, 28 ref.

Descriptors: *Adsorption, *Coal, *Dyes, *Fly ash, *Wastewater treatment, Hydrogen ion concentration, Particle size, Physicochemical properties, Temperature.

The removal of Omega Chrome Red ME (a popular chrome dye) from its aqueous solutions by adsorption on a homogenous mixture of fly ash and

coal in different proportions has been carried out. It has been noted that low adsorbate concentration, small particle size of adsorbent, low temperature and acidic medium favor the removal of the dye. A 100% removal of the said dye was achieved at 10 mg/L, 30 C, 2.0 pH and 53 micron particle size, using a 1:1 ratio of fly ash and coal. The equilibrium data fit well in the Langmuir model of adsorption, showing the formation of monolayer coverage of dye molecules at the outer surface of the adsorbent. Effect of temperature was explained on the basis of solubility and chemical potential of the adsorbate. An attempt has been made to explain the results thus obtained on the basis of various physicochemical properties of the solid-solution interface involved in the process of removal. (Author's abstract)
W90-06071

REACTOR DESIGN FOR HAZARDOUS WASTE TREATMENT USING A WHITE ROT FUNGUS.
New Jersey Inst. of Tech., Newark. Dept. of Chemical Engineering.
G. A. Lewandowski, P. M. Armenante, and D. Pak.
Water Research WATRAG, Vol. 24, No. 1, p 75-82, January 1990. 6 fig, 4 tab, 26 ref.

Descriptors: *Design standards, *Fungi, *Hazardous wastes, *Wastewater reactors, *Wastewater treatment, Biodegradation, Chlorinated aromatic compounds, Microbiological studies, Nutrients, Phanerochaete chrysosporium, Silica.

Various nutrient media and reactor configuration were explored in order to grow the white rot fungus Phanerochaete chrysosporium, induce its active enzyme system, develop kinetic data for the degradation of 2-chlorophenol and use chemical engineering analysis to design an effective reactor. Preliminary experiments indicated that the biodegradation rate was improved by a factor of 40 when the fungus was immobilized. As a result, the project focused on packed-bed reactor employing a silica-based porous support for the fungus, and a well-mixed reactor employing alginate beads as the immobilizing medium. Both were very effective in degrading 20 chlorophenol at inlet concentrations up to 520 ppm. Apparent Michaelis-Menten kinetic rate constants were developed for both reactors, which to our knowledge are the first reactor design parameters to be published for this fungus for treating a hazardous waste. (Author's abstract)
W90-06075

LIMNOLOGICAL ASPECTS OF SMALL SEWAGE PONDS.
Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.
T. J. Wrigley, and D. F. Toerien.
Water Research WATRAG, Vol. 24, No. 1, p 83-90, January 1990. 7 fig, 6 tab, 26 ref.

Descriptors: *Limnology, *Wastewater lagoons, *Wastewater treatment, Algae, Ammonia, Biodegradation, Biomass, Chlorophyll a, Inorganic compounds, Nitrogen, Phosphates, Phosphorus, Productivity, Respiration, Seasonal variation, Suspended solids, Toxicity.

Four small-scale sewage ponds were linked in series and fed settled sewage for 21 months. Inorganic nutrient ammonia nitrogen and phosphate phosphorus removal was primarily by biological uptake and export as algal material. Ammonia nitrogen was reduced by 82% in the pond stream, half of this removal according to chlorophyll-a and total suspended solids data occurring in pond 1. Up to 50% of the influent phosphate phosphorus concentration was removed in the pond system, removal rates of between 10-20% occurring, respectively, in three of the four ponds. Uptake by and export as algal biomass indicated that between 16-65% of the phosphate phosphorus removed was by these processes in the ponds. Chlorophyll-a and total suspended solids concentrations were significantly correlated for ponds, 2, 3 and 4 suggesting that the majority of solids exported from the ponds was algal material. Laboratory algal bioassays indicated that ammonia toxicity was present in the settled sewage inflow and pond 1 water. The ponds were highly productive according to productivity values calculated from diurnal oxygen curves. Winter and spring productivity values were on the whole greater than those in summer. Production/respiration ratios of the ponds were close to 1. suggesting that these ponds were relatively robust and stable systems. The flagellated algal genera, Euglena, Lepocinclis and Chlamydomonas were dominant in association with Micractinium. Zooplankton biomass was low in ponds 1, 2 and 3, probably because of an exclusion effect of high pH and ammonia nitrogen concentrations. In pond 4, zooplankton biomass peaked during dominance of flagellated algae. (Author's abstract)
W90-06076

EFFECT OF TEMPERATURE AND PH ON THE EFFECTIVE MAXIMUM SPECIFIC GROWTH RATE OF NITRIFYING BACTERIA.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
P. Antoniou, J. Hamilton, B. Koopman, R. Jain, and B. Holloway.
Water Research WATRAG, Vol. 24, No. 1, p 97-101, January 1990. 4 fig, 1 tab, 18 ref. NSF Grant EET-8657394.

Descriptors: *Growth rates, *Hydrogen ion concentration, *Nitrogen fixing bacteria, *Temperature, *Wastewater treatment, Biodegradation, Microbiological studies, Sludge treatment.

For modeling nitrification in wastewater treatment processes it is necessary to determine the dependence of the maximum specific growth rate of nitrifying bacteria on temperature and pH. A functional relationship for the simultaneous dependence of the effective maximum specific growth rate minus the decay coefficient on temperature and pH, obtained from theoretical arguments, was verified via batch experiments with sludge from a local wastewater treatment plant. The parameters for the functional relationship were determined from the experimental data using a nonlinear regression scheme. An optimum pH of 7.8 was determined and the effective maximum specific growth rate was found to be monotonically increasing function of temperature in the range of 15-25 C. (Author's abstract)
W90-06078

PAC ADDITION AS A MEANS OF REGENERATING GAC IN A GAC FLUIDIZED-BED REACTOR.
General Motors Research Labs., Warren, MI. Environmental Science Dept.
B. R. Kim, and M. B. Cognata.
Water Research WATRAG, Vol. 24, No. 1, p 103-109, January 1990. 6 fig, 1 tab, 15 ref, append.

Descriptors: *Activated carbon, *Fluidized bed process, *Granular activated carbon, *Powdered activated carbon, *Wastewater treatment, Adsorption, Desorption, Evaluation, Flow rates, Nitrophenols.

When the adsorption capacity of a biological, GAC (granular activated carbon) fluidized-bed reactor is exhausted, a portion of the exhausted GAC may have to be replaced with fresh GAC. As an alternative, the addition of powdered activated carbon to the fluidized-bed reactor in which the GAC was already exhausted was examined. The effectiveness of this scheme was evaluated using p-nitrophenol as a model compound to study the adsorption-desorption behavior of the system. The p-nitrophenol, adsorbed on granular activated carbon, was desorbed with deionized water in the presence and in the absence of powdered activated carbon in the reactor to determine whether powdered activated carbon expedites the desorption process. Desorption of p-nitrophenol was accelerated in the presence of powdered activated carbon, indicating that partial regeneration of exhausted granular activated carbon could be achieved by periodically adding powdered activated carbon to the fluidized-bed reactor. During the experiments with powdered activated carbon, the majority of the added powdered activated carbon was not flushed out of the reactor even at a relatively high recirculation flow rate because the flow regime near the effluent port was dominated by the feed flow rate, not by the recirculation flow rate. This prolongs the usefulness of the added powdered activated carbon. (Author's abstract)
W90-06079

MICROCOMPUTER-BASED INSTRUMENTATION SYSTEM FOR ANAEROBIC WASTEWATER TREATMENT PROCESSES.
Washington Univ., Seattle. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 7B.
W90-06082

SEPTIC SYSTEM DENSITY AND GROUNDWATER CONTAMINATION IN ILLINOIS: A SURVEY OF STATE AND LOCAL REGULATION.
American Planning Association, Chicago, IL.
For primary bibliographic entry see Field 5G.
W90-06162

GUIDE TO LAND TREATMENT OF MUNICIPAL WASTEWATER IN ILLINOIS.
Institute of Technology Assessment, Springfield, IL.
L. W. Skelton, T. D. Hinesly, and S. F. John.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-163026. Price codes: A04 in paper copy, A01 in microfiche. Report No. ILENR/RE-PA-88/12, January 1989. 83p, 5 fig, 21 ref, append.

Descriptors: *Illinois, *Land disposal, *Municipal wastewater, *Wastewater treatment, Economic aspects, Management planning, Site selection, Wastewater management.

Wastewater is a recyclable commodity. The water itself can, after sufficient purification, be reused for agriculture, silviculture or aquaculture; irrigation of lawns, golf courses or horticultural plants; industrial cooling and process water; revegetation of disturbed lands such as strip-mined areas; or recharge of aquifers. Organic matter, nitrogen, phosphorus and micronutrients in wastewater are generally harmful when discharged to lakes and streams, but these constituents have a positive economic value when applied under properly controlled conditions to vegetated soils. Advocates of wastewater land treatment maintain that the beneficial reuse of wastewater and the nutrients it contains ought to be the rule rather than the exception. At the present time, however, treatment and discharge into surface waters is the more common approach to wastewater management in the United States. This guide provides an overview of planning for a land treatment system. It first discusses the potential for land treatment in Illinois, how to modify lagoons for land treatment, economic considerations, health and environmental concerns, regulatory requirements, and public education. It then provides more technical information on land treatment processes, site and wasteload evaluation, systems for agricultural production, the potential for supplemental irrigation in Illinois, general site management, and system monitoring. (Author's abstract)
W90-06176

ILLINOIS SELF-HELP CONSORTIUM FOR WATER AND WASTEWATER PROJECTS.
Illinois Community Action Association, Springfield.
For primary bibliographic entry see Field 5G.
W90-06192

SLUDGE INCINERATION MODELING (SIM) SYSTEM USER'S GUIDE.
General Sciences Corp., Laurel, MD.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-149314. Price codes: A04 in paper copy, A01 in microfiche. March 1989. 62p, append.

Descriptors: *Computer models, *Computer programs, *Incineration, *Model studies, *Sludge disposal, *Sludge treatment, Handbooks, Industrial Source Complex Long-Term model.

A user-friendly, menu-driven PC version of the Ind
W90-06194

RAPID DESTRUCTION OF ORGANIC CHEMICALS IN GROUNDWATER USING SUNLIGHT.
Sandia National Labs., Albuquerque, NM. Solar Thermal Collector Technology Div.
C. E. Tyner, J. E. Pacheco, C. A. Haslund, and J. T. Holmes.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-006766. Price codes: A02 in paper copy, A01 in microfiche. Report No. SAND--89-0236c, (1989). 8p, 5 fig, 10 ref. DOE Contract DE-AC04-76DP00789.

Descriptors: *Groundwater pollution, *Organic compounds, *Photolysis, *Water pollution treatment, Catalysis, Salicylic acid, Titanium dioxide, Ultraviolet radiation.

This study investigates a solar-driven photocatalytic process that promises to destroy low concentrations of hazardous organic molecules in large volumes of contaminated groundwater or industrial waste streams. Preliminary results of laboratory-scale screening tests using a model compound, salicylic acid, and titanium dioxide catalyst have shown that no measurable reaction occurs without both UV light and catalyst; no measurable volatilization of the salicylic acid occurs at room temperature; salicylic acid destruction rates depend on catalyst supplier and concentration and on UV light intensity; and some intermediates are being formed and subsequently destroyed. Observed reaction rates are consistent with those observed in an initial pilot-scale solar test of a falling-film reactor, although further testing will be required to quantify the comparison. (Author's abstract)
W90-06199

EVALUATION CRITERIA GUIDE FOR WATER POLLUTION PREVENTION, CONTROL, AND ABATEMENT PROGRAMS.
Department of the Army, Washington, DC.
For primary bibliographic entry see Field 5G.
W90-06211

REMOVAL OF TOXIC HEAVY METALS FROM CONTAMINATED GROUNDWATER BY A FUNGAL ADSORPTION PROCESS.
Delaware Univ., Newark. Dept. of Civil Engineering.
C. Huang, C. P. Huang, A. L. Morehart, and D. C. Westman.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-138637/AS. Price codes: A07 in paper copy, A01 in microfiche. Final Technical Report, 1989. 121p, 72 fig, 22 tab, 100 ref. USGS Contract 14-08-0001-G1292.

Descriptors: *Adsorption, *Biofilm reactors, *Fungi, *Heavy metals, *Wastewater renovation, *Wastewater treatment, Aspergillus oryzae, Computer models, Groundwater pollution, Pretreatment, Saccharomyces cerevisiae.

The metal adsorption behavior of 12 species of fungi was investigated using batch reactors. Specific surface area and surface characteristics of the fungal biomass were determined. Two typical fungal species, Aspergillus oryzae and Saccharomyces cerevisiae were chosen for further investigation. Factors such as growth conditions, pretreatment of biomass and pH of the metal solution were thoroughly studied. The results indicate that the optimum growth condition for metal take-up by A. oryzae biomass was at the C/N ratio of 10-15. The amounts of Cu(II), Cd(II), Zn (II) and Ni(II) removal increased with pH. The removal of Pb(II) by fungal biomass is pH-independent. Metal-laden fungal biomass can be regenerated by acid-washing. Moreover, the acid-washing is the most effective pretreatment of biomass for heavy metal removal. The adsorption of various metals onto fungal wall can be described by either single-site or multiple-site Langmuir isotherm using both the modified Langmuir plot and the Scatchard plot. Heavy metal removal with columns packed with pelleted A. oryzae or immobilized yeast cells of sand bed was conducted. A finite difference computer model was applied to simulate the performance of these column reactors. (USGS)
W90-06237

5E. Ultimate Disposal Of Wastes

STUDIES OF GEOLOGY AND HYDROLOGY IN THE BASIN AND RANGE PROVINCE, SOUTHWESTERN UNITED STATES, FOR ISOLATION OF HIGH-LEVEL RADIOACTIVE WASTE--CHARACTERIZATION OF THE RIO GRANDE REGION, NEW MEXICO AND TEXAS.
For primary bibliographic entry see Field 2F.
W90-05732

RETENTION, DETENTION, AND OVERLAND FLOW FOR POLLUTANT REMOVAL FROM HIGHWAY STORMWATER RUNOFF: INTERIM GUIDELINES FOR MANAGEMENT MEASURES.
Versar, Inc., Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-05754

SEPTIC TANK ABSORPTION SYSTEMS: A LITERATURE REVIEW.
National Building Research Inst., Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W90-05791

MANAGEMENT OF EFFLUENTS/BY-PRODUCTS OF MULTI-PURPOSE FINE CHEMICAL MANUFACTURE.
Imperial Chemical Industries Ltd., Manchester (England). Organics Div.
For primary bibliographic entry see Field 5D.
W90-05802

SPRAY DISPOSAL OF DREDGED MATERIAL IN LOUISIANA WETLANDS: HABITAT IMPACTS AND REGULATORY POLICY IMPLICATIONS.
Louisiana Sea Grant Coll. Program, Baton Rouge.
D. R. Cahoon, and J. H. Cowan.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-173124. Price codes: A03 in paper copy, A01 in microfiche. 27p, 13 fig, 3 tab, 21 ref.

Descriptors: *Dredging wastes, *Environmental effects, *Louisiana, *Spoil banks, *Waste disposal, *Water pollution prevention, *Wetlands, Ecological effects, Marshes, Regulations, Salt marshes, Spraying, Vegetation.

Dredging canals for navigation, pipelines, and access to drilling sites is a common activity in the Louisiana coastal zone. Traditionally, the spoil dredged during construction is banked alongside the canal at elevations significantly higher than the surrounding marsh. Minimizing the impacts associated with spoil banks is a major concern of state and federal agencies regulating development in wetlands. Current regulatory practices of the Louisiana Department of Natural Resources' Coastal Management Division (LDNR/CMD) require that access canals must be plugged and spoil either gapped or backfilled when wells are abandoned. The regulatory requirements of federal agencies are similar in intent and scope. High-pressure spray disposal of spoil in saline marshes has great potential to minimize dredging related impacts on Louisiana's coastal resources. Salt marsh at the disposal site is not converted to upland shrub/scrub habitat because a spoil bank two to six feet high is not created on the marsh surface. Vegetation at the disposal site is crushed, as it is with conventional bucket dredging, but the sprayed marsh is recolonized by intertidal marsh plants. High-pressure spray disposal is capable of depositing spoil in a thin layer (approximately four inches), giving it great potential for minimizing hydrologic impacts and maintaining marsh elevations. Further research is needed, however, to determine if this potential is actually being realized. (Lantz-PTT)
W90-05828

PREDICTING ORGANIC ACCUMULATION IN SEDIMENTS NEAR MARINE OUTFALLS.
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
K. J. Farley.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 144-165, January/February 1990. 9 fig, 23 ref, append. USEPA Contract 68-01-6938.

Descriptors: *Coastal waters, *Marine sediments, *Organic matter, *Outfall sewers, *Path of pollutants, *Sediment contamination, Coagulation, Kinetics, Mathematical models, Model studies, Ocean circulation, Organic carbon, Sedimentation, Tidal effects, Water currents.

The impacts of wastewater discharges in coastal waters are largely exhibited in sediment composition changes. Processes controlling the accumulation of organic material in sediments near submerged sewage outfalls include tidal oscillations, wind-driven currents, and large-scale mean circulation. A simplified model is formulated for predicting particle deposition and organic accumulation in surface sediments. The model is based on mathematical descriptions of coastal transport, particle dynamics, and organic carbon cycles and includes a second-order kinetic description for the coagulation and settling of sewage particles and natural organic material. Sample calculations are presented demonstrating the importance of coagulation and settling behavior and tidal motion in determining the pronounced changes in deposition and sediment composition near outfalls. Model applications are presented for the Orange County and Los Angeles County outfalls using predetermined modeling coefficients. Results compare quite well to field observations for both outfalls demonstrating the capabilities of the model in predicting deposition and accumulation of organic material in surface sediments near sewage outfalls in deep coastal waters. (Author's abstract)
W90-05961

ACOUSTIC IMAGING OF SUBSURFACE FEATURES.
Oak Ridge National Lab., TN. Energy Div.
A. J. Witten, and W. C. King.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 166-181, January/February 1990. 10 fig, 22 ref.

Descriptors: *Acoustics, *Geophysical surveys, *Hazardous waste disposal, *Subsurface mapping, *Tomography, Remote sensing, Underground waste disposal.

The characterization of sites containing buried hazardous wastes and the selection of new waste disposal sites have become important problems for environmental engineers. Because of the potential risks associated with uncertainty of the subsurface environment, increasing effort has been dedicated to application of available remote sensing techniques. One such technique which is quantitative and offers high resolution is an acoustic approach involving geophysical tomography (GT). Two approaches to GT are examined: backprojection, which traces straight ray paths, and backpropagation, which inverts the wave equation. Results of field studies demonstrate that buried inclusions having length scales on the order of 0.5 m can be resolved using GT and that identification of differing buried waste forms is possible. This method has been successfully demonstrated for a number of applications such as detecting leakage of underground fuel or waste storage tanks and shows great promise for many more applications. (Author's abstract)
W90-05962

EFFECTS OF PHENOL WASTEWATER CO-DISPOSAL ON THE ATTENUATION OF THE REFUSE LEACHATE MOLECULE HEXANOIC ACID.
University of Strathclyde, Glasgow (Scotland). Dept. of Bioscience and Biotechnology.
For primary bibliographic entry see Field 5B.
W90-05964

INDUSTRIAL PROPERTY TRANSFER EVALUATIONS: LIMITING LIABILITY.
B and V Waste Science and Technology Corp., Philadelphia, PA.
For primary bibliographic entry see Field 6B.
W90-05976

EFFECTS OF MUNICIPAL SLUDGE ON LOCOMOTOR ACTIVITY AND EXPLORATORY BEHAVIOR OF MEADOW VOLES, MICROTUS PENNSYLVANICUS.
Miami Univ., Oxford, OH. Dept. of Zoology.
A. T. Hall, D. H. Taylor, and P. E. Woods.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 1, p 31-36, 1990. 2 fig, 2 tab, 34 ref. EPA Grant R-81238501.

Descriptors: *Animal behavior, *Bioaccumulation, *Heavy metals, *Land disposal, *Municipal wastes, *Rodents, *Sludge disposal, *Sludge utilization, Behavior, Cadmium, Copper, Lead, Path of pollutants, Sludge, Soil contamination, Sublethal effects, Tissue analysis, Toxicity, Zinc.

Behavioral responses of meadow voles (microtus pennsylvanicus), inhabiting sludge-treated outdoor enclosures, were studied during the 1987 growing season. Significant accumulations of Cd, Cu, Pb and Zn were found in the soils of sludge-treated enclosures. Significant uptake of Zn and Cd were observed in Poa spp., while Bromus japonicum significantly accumulated An. Additionally, Bromus from the sludge-treated enclosures showed a strong trend of increased Cd. Both of these plant species are potentially eaten by voles. Both male and female sludge-exposed voles significantly bioaccumulated Cd in their livers and brains. Alterations in locomotor activity and exploratory behavior were found in sludge-exposed females that appeared either not to habituate to the novel environment of the activity chamber, or were hyperactive as a consequence of Cd exposure, or possibly an interaction between the two. No changes in behavior of males exposed to sludge was observed. Observed differences between the male and female voles might be due to sex-related differential responses to Cd toxicity. (Author's abstract)
W90-06047

BRACHIONUS PLICATILIS TOLERANCE TO LOW OXYGEN CONCENTRATIONS.
Valencia Univ. (Spain). Dept. of Ecology.
For primary bibliographic entry see Field 2H.
W90-06156

STUDIES OF GEOLOGY AND HYDROLOGY IN THE BASIN AND RANGE PROVINCE, SOUTHWESTERN UNITED STATES, FOR ISOLATION OF HIGH-LEVEL RADIOACTIVE WASTE–CHARACTERIZATION OF THE DEATH VALLEY REGION, NEVADA AND CALIFORNIA.
For primary bibliographic entry see Field 2F.
W90-06160

DESIGN, CONSTRUCTION, AND EVALUATION OF CLAY LINERS FOR WASTE MANAGEMENT FACILITIES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste and Emergency Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-181937. Price codes: A24 in paper copy, A01 in microfiche. Report No. EPA/530/SW-86/007F, November 1988. 516p, 117 fig, 53 tab, 349 ref, append. EPA Contract 68-03-7310.

Descriptors: *Clay liners, *Design standards, *Landfills, *Liners, *Reservoirs, *Waste disposal, *Waste management, Case studies, Construction, Hydraulic conductivity, Literature review, Soil properties.

This Technical Resource Document (TRDT) is a compilation of available information on the design, construction, and evaluation of clay liners for landfills, surface impoundments and wastepiles. The information was obtained from the literature and from in-depth interviews with design and construction engineers and other knowledgeable individuals in both the private and government sectors. As a consequence, some information is presented for the first time in this document. The broad topics covered are: clays with emphasis on their composition, fabric, and hydraulic conductivity; geotechnical test methods and soil properties including soil classification, and hydraulic conductivity testing; clay chemical compatibility, including a discussion of the mechanisms of interaction and a compilation of test data from the literature and private sources, construction and quality assurance; clay liner failure mechanisms; the performance of existing clay liners based on case studies of 17 sites; and clay liner transit time prediction methods including discussion of many available techniques and models. (Author's abstract)
W90-06163

GUIDE TO LAND TREATMENT OF MUNICIPAL WASTEWATER IN ILLINOIS.
Institute of Technology Assessment, Springfield, IL.
For primary bibliographic entry see Field 5D.
W90-06176

SLUDGE INCINERATION MODELING (SIM) SYSTEM USER'S GUIDE.
General Sciences Corp., Laurel, MD.
For primary bibliographic entry see Field 5D.
W90-06194

EVALUATION PROCEDURES TECHNICAL APPENDIX. PHASE I (CENTRAL PUGET SOUND): SAMPLING, TESTING, AND TEST INTERPRETATION OF DREDGED MATERIAL PROPOSED FOR UNCONFINED, OPEN-WATER DISPOSAL IN CENTRAL PUGET SOUND.
Evaluation Procedures Work Group, Seattle, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A205-290. Price codes: A18 in paper copy, A01 in microfiche. June 1988. 445p, 42 fig, 51 tab, 28 exhibits, 96 ref.

Descriptors: *Dredging, *Dredging wastes, *Waste disposal, *Waste management, Confined disposal, Contaminated sediments, Dikes, Land disposal, Management planning, Ocean dumping, Puget Sound.

The document is a technical appendix to the Management Plan Report (MPR) for the Puget Sound Dredged Disposal Analysis (PSDDA) study, and was prepared by the Evaluation Procedures Work Group (EPWG). Part I of the technical appendix contains background and introductory information for dredged material management. The remaining parts are organized by disposal option and address the technical conclusions of EPWG. The PSDDA study focuses on unconfined, open-water disposal, discussed in detail in part II. In addition to technical recommendations, a detailed cost analysis is presented based on alternative chemical and biological guidelines for disposal of dredged material at unconfined, open-water sites. In part III, disposal on land or intertidal areas using a conventional design is briefly addressed. Confined disposal of contaminated sediments is also discussed. Capping an aquatic disposal site is one method of confined disposal. Two other methods are diked nearshore (i.e., intertidal) and upland disposal. The technical appendix is concluded with a list of references, a glossary, and several exhibits. (Lantz-PTT)
W90-06213

HYDROGEOLOGY AND RESULTS OF AQUIFER TESTS IN THE VICINITY OF A HAZARDOUS-WASTE DISPOSAL SITE NEAR BYRON, ILLINOIS.
Geological Survey, Urbana, IL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06220

VARIABLE-DENSITY GROUND-WATER FLOW AND PALEOHYDROLOGY IN THE WASTE ISOLATION PILOT PLANT (WIPP) REGION, SOUTHEASTERN NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-06230

5F. Water Treatment and Quality Alteration

ECONOMIC ANALYSIS OF TREATMENT TECHNOLOGIES TO ACHIEVE VOC REMOVAL TO SAFE LEVELS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark, and J. Q. Adams.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-129407. Price codes: A04 in paper copy, A01 in microfiche. Report no. EPA/600/D-88/245, November 1988. 54p, 16 fig, 8 tab, 18 ref.

Descriptors: *Water treatment, *Volatile organic compounds, *Granular activated carbon, *Aeration, Economic aspects, Model studies, Dichloroethane, Trichloroethylene, Vinyl chloride, Organic compounds, Costs.

Both granular activated carbon (GAC) and packed tower aeration (PTA) have been designated as best available treatment technology in the volatile organic compound (VOC) regulations. Cost and performance models have been developed to examine various treatment scenarios for controlling VOCs. The constant-pattern-homogeneous-surface-diffusion model (CPHSDM) was utilized to predict liquid-phase GAC use rates for selected single-solute VOCs. In this analysis, eight currently regulated VOCs were examined. Only one of the compounds, p-dichlorobenzene, exhibited a bed life greater than 2 years, typical of taste-and-odor control applications using GAC. Most of the VOCs exhibited bed lives in the range of 6 to 24 months with empty bed contact times (EBCTs) of 10 and 15 minutes. Three VOCs (1,2,-dichloroethane; 1,1,1-trichloroethylene; and vinyl chloride) had predicted bed lives of < 3 months. Preliminary cost estimates for liquid-phase GAC treatment systems have been developed for a range of plant sizes, EBCTs and carbon bed lives. Most of VOCs examined exhibited bed lives of 6 months or longer. Cost estimates for these scenarios range from about 34-45 cents/1,000 gal for a 1 million gallon/day (mgd) system, to about 20-30 cents/1,000 gal for a 10 mgd system to about 11-15 cents/1,000 gal for a 100 mgd system. A cost and performance model has been developed to examine various scenarios for controlling VOCs by packed tower aeration (PTA) including off-gas treatment. Preliminary cost estimates for PTA excluding off-gas control varied from 49 cents/1,000 gal (treating 1,2-dichloroethane) to 35 cents/1,000 gal (treating vinyl chloride) for a 0.1 mgd system, 21 to 10 cents/1,000 gal for a 1 mgd system, and 14 to 6 cents/1,000 gal for a 10 mgd system. System cost approximately doubles or triples when gas-phase GAC treatment is included in the PTA system for off-gas control. A comparison was made between liquid-phase GAC and PTA treatment alternatives. For all VOCs in this analysis, PTA treatment as more cost effective than liquid-phase GAC at all system sizes when assuming no PTA off-gas control. (Lantz-PTT)
W90-05755

NEW WATER TREATMENT FACILITY IMPROVES EFFICIENCY.
BCM Engineers, Mobile, AL.
J. A. Holifield.

Public Works PUWOAH, Vol. 121, No. 1, p 67-69, January 1990.

Descriptors: *Alabama, *Design criteria, *Project planning, *Water treatment facilities, Automation, Costs, Filtration, Sludge.

Building or expanding water supply systems that are technologically reliable and economically feasible requires considerable planning and no small amount of innovative thinking. The challenge was recently met by the city of Mobile, Alabama, which had to come up with a master plan to meet its steadily increasing demand for water. The city was faced with a choice of expanding its existing facility to meet future need, or building a new facility close to the area of growth. Because of the cost of the changes required to expand the existing facility it was decided to build a new plant. A second plant also provided the advantage of additional fire protection, enabled the city to solve a problem with processing sludge from the existing plant, and could be designed to be expandable to meet future needs. The new plant is rated at 40 mgd, and is expandable to 80 mgd. Innovative technical features include a computer controlled filtration system that informs the operator when the filters require backwashing, override systems to ensure operation of the filtration system during malfunctions, a closed circuit television security system, and overall plant design intended to simplify operation and reduce construction and maintenance costs. The operating and maintenance expenses for the new facility are projected to be the same as current expenses. (Tappert-PTT)
W90-05892

TURNKEY WELL, RESERVOIR, AND PUMP STATION IN AN ARID REGION.
Engineering-Science, Inc., Phoenix, AZ.
K. R. James.
Public Works PUWOAH, Vol. 121, No. 1, p 79-80, January 1990. 1 fig.

Descriptors: *Arid lands, *Arizona, *Production wells, *Reservoir design, *Water resources development, *Water supply, Groundwater management, Pumps, Reservoir evaporation, Reservoir linings.

During the last ten years population growth in the Phoenix suburb of Gilbert has increased 400 percent, from 5,000 people to over 20,000 people. This population increase, coupled with high average daily maximum temperatures (104 F in July) and an average rainfall of 7.5 inches, created a critical condition in Gilbert's water supply. A water resources study recommended adding eight 1,500 gpm wells and constructing a new 45 mgd surface water treatment plant to meet future demand. To meet a desire to have additional water facilities online by 1989, Gilbert arranged for a turnkey project that included one 1,500 gpm well, a 4 MG reservoir, and a booster pumping station. Test well samples indicated a nitrate concentration in excess of drinking water standards within 500 feet of the surface, and fluoride levels exceeding drinking water standards at the deepest zones of the 1,000 foot deep well. The production well was cased to eliminate the undesirable water. The reservoir was lined and covered with Hypalon to prevent seepage and evaporation. Two 200-hp pumps provide system pressure. The turnkey approach simplified design, equipment procurement, and construction. The lined and covered reservoir provides significant cost savings for the project. (Tappert-PTT)
W90-05893

SENSITIVITY ANALYSES OF BIODEGRADATION/ADSORPTION MODELS.
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-05955

APPLICATION OF DECLINING RATE FILTRATION THEORY: CONTINUOUS OPERATION.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Civil Engineering.
A. M. Saatci.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 87-105, January/February 1990. 8 fig, 2 tab, 24 ref, append.

Descriptors: *Filters, *Filtration, *Hydraulic conductivity, *Mathematical models, *Water treatment, Comparison studies, Model studies, Performance evaluation, Polymers, Sand filters, Theoretical analysis.

Equations describing the change of hydraulic conductivity with solids accumulation in deep-bed filters are presented. Declining rate filtration theory is extended to incorporate harmonic mean conductivity equations derived using Ives's, Mints's, and Shekhtman's solids accumulation models. The difference among the harmonic mean conductivity values calculated using each model increases with increase of filter run time. Consequently, as filtration time increases, each model predicts increasingly different filter effluent quality, filtrate volume production, and head-loss development. Data obtained from laboratory constant rate filtration, split flow filtration, and true declining rate filtration experiments are compared with the predictions of the theory. Solids accumulation in different layers of sand filter media for constant rate filtration, split flow filtration, and true declining rate filtration are measured with and without polymer application. (Author's abstract)
W90-05958

TUBE SETTLER MODELING.
Mansoura Univ. (Egypt). Faculty of Engineering.
A. A. Fadel, and E. R. Baumann.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 1, p 107-124, January/February 1990. 10 fig, 5 tab, 11 ref.

Descriptors: *Model studies, *Settleable solids, *Settling tanks, *Water treatment, Design criteria, Flow velocity, Performance evaluation, Sedimentation.

A new tube settler model, the Fadel model, useful for tube design and performance evaluation is developed based on the assumption of uniformly distributed flow velocity at the tube entrance. As flow through the tube occurs, the velocity distribution in the tube changes from uniform flow to a fully developed parabolic velocity (laminar) profile at some distance along the tube. The varying velocity encountered by a settling particle results in variations in its settling path. A model is developed based on these effects and is verified in laboratory tests. Using the model, the effects of solids accumulation on the bottom of essentially horizontal tubes on particle settling is predicted with a mean error of about 2%. Laboratory tests indicate that the model predictions are accurate up to the point that 40% of the tube diameter is used for solids storage. (Author's abstract)
W90-05959

AQUEOUS OZONATION OF PESTICIDES: A REVIEW.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
G. Reynolds, N. Graham, R. Perry, and R. G. Rice.
Ozone: Science and Engineering OZSEDS, Vol. 11, No. 4, p 339-382, 1989. 20 fig, 5 tab, 39 ref, append.

Descriptors: *Literature review, *Ozonation, *Pesticides, *Water treatment, Chlorinated hydrocarbons, Fate of pollutants, Nitrogen compounds, Organophosphorus pesticides.

The ozonation reactions of five groups of pesticides (chlorinated hydrocarbons, organophosphorus compounds, phenoxyalkyl acid derivatives, organonitrogen compounds, and phenolic compounds) were reviewed from the literature. For the chlorinated hydrocarbon pesticides reactivity with ozone ranged from slight to substantial. Endosulfan and heptachlor epoxide showed little destruction upon ozonation. Some evidence for epoxide formation following ozone attack at the non-chlorinated double bond of the cyclodiene insecticides aldrin and heptachlor was presented; however, the study of Brower (1966) indicated that the epoxide is unlikely to be the major reaction product following the ozonation of aldrin. In general, a readier removal of the less stable organophosphorus insecticides was demonstrated. Oxons (of malathion, parathion, methyl parathion and phosalone) were identified frequently as products of reaction, as were products of cleavage of the P-S,O bond following malathion and parathion ozonation. Relatively rapid and virtually complete destruction of the herbicides 2,4-D, MCPA and MCPB generally was observed upon ozonation. Limited removal of 2,4,5-T was recorded. The reaction products identified tended to be aliphatic acids of short carbon chain length, carbon dioxide and chloride ion. Low levels of aromatic intermediate compounds were also observed. Virtually complete removal of all organonitrogen pesticides was observed upon ozonation. Complete destruction of the N-aryl-N',N'-dimethyl areas was limited to conditions of high pH and that of the N-heterocycle, atrazine, to periods of prolonged ozonation. The products of reaction identified for carbaryl suggested that reaction between carbamate compounds and ozone occurred either directly at the carbamate group or following hydrolysis of that group. Triazine derivatives were identified as products of ozonation of both five-membered and six-membered N-heterocyclic compounds. Complete removal of the phenolic pesticides was demonstrated upon ozonation. In general, only inorganic anions were identified as products of reaction, namely nitrates and chloride, although dinitrophenols and alcohols were shown to be present following the ozonation of dinobuton and dinocap. (Geiger-PTT)
W90-05972

EVALUATION OF GROWTH MEDIA FOR THE RECOVERY OF ESCHERICHIA COLI FROM OZONE-TREATED WATER BY MEMBRANE FILTRATION.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W90-05973

AZO DYE OZONATION FILM THEORY UTILIZATION FOR KINETIC STUDIES.
Universidad Complutense de Madrid (Spain). Dept. de Ingenieria Quimica.
For primary bibliographic entry see Field 5D.
W90-05974

IN-HOUSE DESIGN AND CONSTRUCTION OF A SCADA SYSTEM.
Springfield Utility Board, OR. Water Operations and Engineering.
K. Cerotsky, and C. Arrera.
Water Engineering and Management WENMD2, Vol. 137, No. 11, p 28-33, November 1989. 2 fig.

Descriptors: *Control systems, *Data acquisition, *SCADA program, *Supervisory control, *Utilities, *Water treatment facilities, Information systems, Oregon, Water users.

Rapid city growth, higher customer expectations, and higher operating costs forced the Springfield water utility (Oregon) Utility Board to improve and modernize its control system. Also, the water system required more timely, accurate information. In 1981, Springfield decided to design and build its own supervisory control and data acquisition (SCADA) system. A SCADA system can provide more reliable water utility service for the customer, reduce operating costs, and provide better information for today's sophisticated water utilities. To date, the Springfield system has cost 475 thousand dollars. This includes the purchase of hardware, software, associated electronics, and personnel time. The project involved reconstruction and upgrading of existing facilities so that it now provides more useful information and monitors more facilities than originally planned. Because of in-house design and phased construction, the Springfield Utility Board was able to incorporate newer technology as they progressed through the project. (Chonka-PTT)
W90-06031

ANCHORAGE LAUNCHES NEW SCADA-CONTROLS.
Ship Creek Treatment Facility, AK.
E. Lindboe.
Water Engineering and Management WENMD2, Vol. 137, No. 11, p 36-40, November 1989. 6 fig.

Descriptors: *Control systems, *Data acquisition, *SCADA, *Supervisory control, *Utilities, *Water treatment facilities, Alaska, Computer programs, Information systems, Process control.

To coordinate three major Alaskan water systems at Anchorage, Eklutna and Ship Creek, the city of Anchorage is using a supervisory control and data acquisition (SCADA) system to (1) receive and store accurate and reliable operating information from in-plant process transmitters; (2) perform real-time process control for the filter system; (3) receive and store manually-entered information such as laboratory test results and chemical dosages; (4) make calculations on transmitted and manually entered data for operator guidance and report generation; (5) display collected and calculated data to the operator to aid in the operation of the water treatment facility in graphic and list form; (6) prepare logs such as alarm and operating logs as well as daily and monthly reports to assist operating, maintenance, and management personnel in evaluating facility operations and improving facility performance; and (7) monitor system operations and alert the operator when abnormal conditions exist which may require intervention. Currently, the system is monitoring slightly more than 1,400 sampling points, but it can be expanded to 2,000 points without adding additional software. (Chonka-PTT)
W90-06032

CARBAMATE INSECTICIDES: REMOVAL FROM WATER BY CHLORINATION AND OZONATION.
Hebrew Univ. of Jerusalem (Israel). Div. of Environmental Sciences.
Y. Mason, E. Choshen, and C. Rav-Acha.
Water Research WATRAG, Vol. 24, No. 1, p 11-21, January 1990. 11 fig, 4 tab, 42 ref.

Descriptors: *Carbamate pesticides, *Chlorination, *Insecticides, *Ozonation, *Water treatment, Aldicarb, Carbaryl, Chemical analysis, Chlorine, Chlorine dioxide, Degradation, Methomyl, Ozone, Propoxur.

A simple approach for removal of carbamates from drinking water by disinfection is presented. Four carbamates, aldicarb, methomyl, carbaryl and propoxur were reacted with excess of each of three disinfectants, chlorine, chlorine dioxide, and ozone. Carbaryl and propoxur did not react with chlorine, none of the selected carbamates reacted with chlorine dioxide and all reacted very rapidly with ozone. The reaction kinetics were determined for aldicarb and chlorine and for methomyl and chlorine dioxide. Product analysis for the reaction of aldicarb and chlorine was carried out using reverse-phase high performance liquid chromatography and gas chromatography/mass spectrometry. The common degradation products, aldicarb-sulfoxide and aldicarb-sulfone were found together with other by-products. A mechanism is suggested based upon an electrophilic ionic attack by hypochlorous acid. A possible mechanism of electrophilic attack by ozone is also suggested. A preliminary bioassay using Daphnia magna, to compare the toxicity of aldicarb and chlorination by-products of aldicarb showed that the by-products were less toxic. Therefore, removal/degradation of these carbamates can be achieved using chlorine and/or ozone, but not chlorine dioxide. (Author's abstract)
W90-06067

OZONATION OF ETHYLENEDIAMINETETRAACETIC ACID (EDTA) IN AQUEOUS SOLUTION, INFLUENCE OF PH VALUE AND METAL IONS.
Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Radiochemie.
E. Gilbert, and S. Hoffmann-Glewe.
Water Research WATRAG, Vol. 24, No. 1, p 39-44, January 1990. 14 fig, 15 ref.

Descriptors: *Ethylenediaminetetraacetic acid, *Hydrogen ion concentration, *Metals, *Ozonation, *Water treatment, Ammonia, Cadmium, Calcium, Formic acid, Glycine, Hydrogen peroxide, Iron, Nitriloacetic acid, Organic carbon, Oxidation.

Ozonation of ethylenediaminetetraacetic acid (EDTA) (C = 1 mmol/L, ozone dose 10 mg/min/L in aqueous solution as a function of pH value (pH 3 and 7)) was investigated. At pH 3 ethylenediaminediacetic acid, iminodiacetic acid, nitrilotriacetic acid, glyoxylic-, oxalic-, formic acid, glycine, ammonia, nitrate and hydrogen peroxide were identified and their quantities, as a function of ozone consumption, were measured. At pH 7 the same oxidation products, except formic acid and hydrogen peroxide are formed. The carbon balance shows that, at pH 3, 84% and, at pH 7, 62-81% of the organic carbon was covered by the identified products. After 100% EDTA-elimination the oxidation products are biodegradable. While the presence of calcium and cadmium ions has only little impact on EDTA-elimination, the rate of EDTA degradation is notably reduced by the addition of ferric ions. (Author's abstract)
W90-06070

EVALUATION OF THE SECONDARY EFFECTS OF AIR STRIPPING.
Montgomery (James M.), Inc., Pasadena, CA.
M. D. Umphres, and J. H. Van Wagner.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-161517. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/2-89/005, March 1989. 87p, 32 fig, 28 tab, 14 ref. EPA Contract CR-809974.

Descriptors: *Air stripping, *Water pollution sources, *Water treatment, Aeration, Bacteria, Calcium carbonate, Coliforms, Costs, Model studies, Trichloroethylene, Turbidity, Volatile organic compounds, Water temperature.

At a 2.9 million gallon per day (mgd) well contaminated with several volatile organic compounds (VOCs), principally trichloroethylene (TCE), a packed tower aerator (PTA) was pilot tested, designed, constructed and monitored during its first seven months of operation. Pilot testing was based on gas/liquid mass transfer theory. Calculated mass transfer coefficients coupled with this theory were used to design the full-scale aerator for TCE control. Modeling of VOC off-gas dispersion was required for a permit to construct in southern California. In addition to liquid-phase VOCs, other parameters including bacteria, turbidity, particle counts, noise, and air-phase VOCs were monitored to assess the secondary effects of aeration. Secondary effects refer to the air, water, and ambient quality that might be affected by control of VOCs. Calcium carbonate was found to deposit on the lowest packing and a downstream pump. This was consistent with the calculated Langlier Index for treated water being mildly scale forming. Sodium hexametaphosphate addition halted deposition. Bacterial levels were found to increase by two logs with aeration, but chlorine addition was corrective. Aeration had not significant effect on water temperature, turbidity and particulates, coliforms, Legionella, or ambient noise. Modeling of TCE off gases indicated levels in the low part-per-trillion range which were not significantly different than ambient TCE levels measured. Factors such as water distribution over the packing, redistribution onto the packing, and changes in packing depth were found to influence PTA performance. A total cost of $<$ $0.10/1000 gallons was demonstrated. (Author's abstract)
W90-06180

URANIUM REMOVAL FROM DRINKING WATER USING A SMALL FULL-SCALE SYSTEM.
Arber (Richard P.) Associates, Inc., Denver, CO.
R. T. Jelinek, R. L. Clemmer, and F. J. Johns.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-169890. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600-89/012, March 1989. 37p, 5 fig, 11 tab, 27 ref, append. EPA Contract 7C7639.

Descriptors: *Drinking water, *Uranium, *Water treatment, Anion exchange, Costs, Gamma radiation, Granular activated carbon, Ion exchange, Maximum contaminant level.

It is anticipated that the US EPA will establish the National Primary Drinking Water Regulation (NPDWR) for uranium as a maximum contaminant level (MCL) at approximately 10 to 40 pCi/L. Of the approximately 60,000 community water systems in the United States, it is estimated that between 100 and 2,000 will require treatment to reduce uranium levels to a concentration within this proposed MCL range. The primary focus of this report is to present the background and history of water quality, basis for design, and actual operating data for a small, full-scale strong base ion exchange system that is used to reduce levels of uranium to less than probable MCL range. The study showed that the small anion exchange system removed the uranium in the raw water, 40-110 micrograms/L (ug/L), to consistently below 1 ug/L for a removal of $>$ 99%. The gamma radiation profile in the small pump house was very low until a granular activated carbon (GAC) system was installed to remove radon. The small system has a capacity of 10 gallons per minute and cost $8,900 to construct. The operation and maintenance costs are estimated to be $4.30/1,000 gallons of water treated. Because of no on-site disposal system, the regeneration wastewater is hauled away to a school district wastewater treatment plant at a cost of $2.40/1,000 gallons of treated water. (Lantz-PTT)
W90-06191

ILLINOIS SELF-HELP CONSORTIUM FOR WATER AND WASTEWATER PROJECTS.
Illinois Community Action Association, Springfield.
For primary bibliographic entry see Field 5G.
W90-06192

COMPARATIVE HEALTH EFFECTS ASSESSMENT OF DRINKING WATER TREATMENT TECHNOLOGIES: REPORT TO CONGRESS.
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5C.
W90-06195

5G. Water Quality Control

SUPERFUND RECORD OF DECISION: LAUREL PARK, CT.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5B.
W90-05718

SORPTION OF SELECTED VOLATILE ORGANIC CONSTITUENTS OF JET FUELS AND SOLVENTS ON NATURAL SORBENTS FROM GAS AND SOLUTION PHASES.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 5B.
W90-05720

SUPERFUND RECORD OF DECISION: TABERNACLE DRUM DUMP, NJ.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-137053. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROD/R02-88/059, June 30, 1988. 104p, 3 fig, 5 tab.

Descriptors: *Water pollution treatment, *Waste dumps, *Soil contamination, *Waste disposal, *Superfund, *Cleanup operations, *New Jersey, *Water pollution sources, Air stripping, Groundwater pollution, Heavy metals, Chromium, Lead, Burlington, Trichloroethane, Methylene chloride, Water pollution treatment.

The Tabernacle Drum Dump site is a one-acre facility located in Tabernacle Township, Burlington County, New Jersey. Drum disposal activities, which resulted in contamination by hazardous substances, occurred on a 2,000 sq ft area portion of the site. In 1976 and 1977, the property was occupied by Mr. and Mrs. Robert Ware. During that period, Mr. Ware's employer, the Atlantic Disposal Services (ADS), disposed of approximately 200 fifty-five gallon drums, twenty gallon containers, and five gallon paint cans. Three containers were stored at the site from 1977 to 1984. Deterioration and leakage of some containers resulted in visible soil contamination and ultimately groundwater contamination. Based on a referral from Tabernacle Township officials, the Burlington County Health Department conducted a site inspection in August 1982, and discovered over 100 abandoned drums. A remedial investigation found the site to be contaminated with trichloroethane, methylene chloride and trichloroethylene (TCE), and heavy metals such as chromium and lead. Pump/treatment using air stripping was the selected remedy for cleanup of the sites. (Lantz-PTT)
W90-05726

SUPERFUND RECORD OF DECISION: SOUTH ANDOVER, MN.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-135354. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R05-88/065, March 30, 1988. 16p, 2 fig, 3 tab.

Descriptors: *Water pollution treatment, *Waste dumps, *Waste disposal, *Superfund, *Cleanup operations, *Minnesota, *Water pollution sources, *Water pollution treatment, Andover, Waste treatment, Chromium, Lead, Volatile organic compounds, Tetrachloroethylene, Trichloroethylene, Toluene, Organic compounds, Costs.

The South Andover site is comprised of several separate parcels of land totalling approximately 50 acres in the southern portion of Andover, Minnesota. The Waste Disposal Engineering landfill, a Superfund National Priorities List Site, is located 3,000 ft northeast of South Andover. Multiple waste handling operations occurred between 1954 and 1981 on several properties within the site boundaries. Waste processing was discontinued in early 1977, and waste acceptance ceased in 1978. In 1980, the Minnesota Pollution Control Agency (MPCA) issued Notices of Violation for improper disposal of industrial wastes. Soil investigations have been limited by the presence of a large volume of tires piled on site and piles of junked automobiles. The majority of the tires are currently being shredded and removed from the site. Currently, the primary contaminants of concern affecting the groundwater include: arsenic, chromium, lead, metals, volatile organic compounds, tetrachloroethylene, trichloroethylene, toluene, and organics. The selected remedial action for this site includes: continuous groundwater extraction; provision of municipal water to private well users on or near the site; groundwater monitoring; and placement of restrictions on new wells on or near the site. The present worth cost for this remedial action ranges from $920,000 to $2,460,000 depending on the discharge option selected. Present worth operations and maintenance ranges from $21,000 to $140,000. (Author's abstract)
W90-05727

SUPERFUND RECORD OF DECISION: LONG PRAIRIE, MN.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-135339. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R05-88/066, June 1988. 58p, 5 fig, 7 tab.

Descriptors: *Superfund, *Cleanup operations, *Minnesota, *Water pollution sources, *Water pollution treatment, *Groundwater pollution, Long Prairie River, Volatile organic compounds, Tetrachloroethylene, Trichloroethylene, Organic compounds, Monitoring, Air stripping, Costs.

The Long Prairie site, as defined by the extent of the plume of contaminated groundwater, extends 2,100 ft by 1,000 ft in Long Prairie, Todd County, Minnesota. The Long Prairie River flows within 500 ft of the contaminant plume. In August and October 1983, routine municipal well monitoring by the Minnesota Department of Health (MDH) indicated contamination in two of five municipal wells. The MDH ordered the two wells shut down in October 1983, and in November 1983, issued an advisory to provide bottled water for area residents. About 50 of the area's 300 private wells were affected by the groundwater contamination. Since the advisory was issued, 39 of the 45 acre homes using contaminated groundwater have connected to the municipal drinking water system. Well monitoring in 1984 implicated an area dry cleaning operation as the potential source of contamination. The primary contaminants of concern affecting 7,000,000 gallons of groundwater and 3,800 cu yd of soil are volatile organic compounds and include: dichloroethane, tetrachloroethylene, and trichloroethylene. The selected remedial action for this site includes: groundwater pump and treatment using air stripping with discharge to the river; spill treatment using active soil venting; and groundwater monitoring. The estimated capital cost for this remedial action is $680,000 with annual operation and maintenance of $290,000 for year 1 and $150,000 for years 2-5. The estimated present worth cost for this remedial action is $21,706,300 without pretreatment, or $23,078,200 including pretreatment, if necessary. (Author's abstract)
W90-05728

SUPERFUND RECORD OF DECISION: DOUGLASSVILLE DISPOSAL, PA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-135305. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/041, June 1988. 39p, 3 fig, 3 tab.

Descriptors: *Waste dumps, *Superfund, *Cleanup operations, *Water pollution sources, *Waste disposal, *Water pollution treatment, Solvents, Pennsylvania, Schuylkill River, Organic compounds, Oil wastes, Volatile organic compounds, Polychlorinated biphenyls, Aromatic compounds, Lead, Costs, Incineration.

The Douglassville Disposal Site occupies approximately 50 acres of land in Union Township, Berks County, Pennsylvania. In 1941, Berks Associates began recycling lubrication oil at the site; waste solvents were recycled in the 1950s and 1960s. Wastes generated from those recycling processes were stored in onsite lagoons from 1941 until 1972. In November 1970, heavy rains caused the lagoons to overflow and release as much as 3,000,000 gallons of wastes down the Schuylkill River. Federal and State actions were initiated to dispose of the waste material remaining in the lagoons. Before this action could be carried out, heavy rains from a hurricane caused the river to overflow its banks and inundate the entire site area in June 1972. An estimated 6,000,000 to 8,000,000 gallons of wastes were carried by floodwaters downstream for about 15 miles. During cleanup after the storm, the lagoons were drained and backfilled by the US EPA. Lubrication oil recycling operations continued at the site until 1979. In late 1985, all oil recycling operations at the facility were completely discontinued. Approximately 200,000 gallons of polychlorinated biphenyl (PCB) and lead contaminated oil and waste sludges remain in storage tanks. The buildings, tanks, tank wastes, and processing equipment are impediments to any future soil and groundwater remediation, and are a source of continuing contamination of these media. The primary contaminants of concern include: volatile organic compounds, PCBs, polycyclic aromatic hydrocarbons, and lead. The selected remedial action for this site includes: removal of liquid and sludge tank waste with transportation to an offsite incineration facility; decontamination of tanks, piping, processing equipment, and building materials; offsite disposal of building rubble, selling of tanks and other metal materials as scrap; offsite disposal of concrete, asphalt, and other materials; and treatment of generated decontamination fluids, as appropriate. The estimated capital cost for this remedial action is $4,050,000. No operation and maintenance will be incurred. (Lantz-PTT)
W90-05729

SUPERFUND RECORD OF DECISION: NORTH CAVALCADE, TX.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-135289. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-88/034, June 1988. 39p, 5 fig, 4 tab, append.

Descriptors: *Water pollution treatment, *Waste dumps, *Waste disposal, *Superfund, *Texas, *Cleanup operations, *Water pollution sources, *Groundwater pollution, Houston, Pentachlorophenol, Aromatic compounds, Volatile organics, Hydrocarbons, Toluene, Organic compounds, Costs, Xylenes, Biological treatment, Incineration.

The 21-acre North Cavalcade site is located in northeast Houston, Texas. The surrounding areas are a mixture of residential, commercial, and industrial properties. Surface water is drained by three stormwater drainage ditches one of which flows into Hunting Bayou, a limited aquatic habitat as classified by Texas Water Quality Standards. The site was developed in 1946 when Houston Creosoting Company, Inc. (HCCI) established creosote wood preserving operations. The property was sold in 1964; there has been no industrial activity at the site since 1964. Between September 1985 and November 1987, EPA sampled all environmental media and found polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and components of creosote in soil, groundwater, and sediments. The area of soil contamination corresponds to where creosote was historically stored, and the point of entry for the contaminants into the groundwater. The plume of contamination currently covers approximately 4 acres. The primary contaminants of concerning affecting the groundwater, soils, and sediments include: VOCs, benzene, toluene, xylene, and PAHs. The selected remedial action for this site includes: in-situ biological treatment of 22,300 cu yd of soil (optimum method will be determined after pilot testing); groundwater pump and treatment of 5,600,000 gallons using oil/water separation and carbon adsorption with reinjection into the aquifer or, if necessary to maintain the water balance, discharge into an onsite drainage ditch which discharges into Hunting Bayou; and offsite incineration of all nonaqueous phase liquids separated out from the groundwater. The estimated present worth cost for this remedial action is $4,210,000. There is no operation and maintenance associated with this remedy. (Author's abstract)
W90-05730

WOOD-DEGRADING FUNGI AS DEGRADERS OF HAZARDOUS WASTE.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
J. A. Glaser.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-129076. Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/258, November 1988. 5p, 17 ref.

Descriptors: *Hazardous wastes, *Biodegradation, *Fungi, *Waste disposal, *Waste treatment, Culturing techniques, Soil treatment, Biomass, Biological studies.

The biological detoxification of hazardous waste is largely an underdeveloped technology. Bacterial species are known to possess a variety of detoxification skills, apparently associated with the need to survive. Single bacterial species may not have the ability to convert a toxicant to carbon dioxide and

water. The use of fungi to degrade waste materials has not been investigated to any extent until recently. Recent research has assessed the effects of selected soil types, temperatures, pH, and water potentials on the growth of fungus in sterile and non-sterile soils. Three well characterized soils (topsoil and subsoil) were used in this work. Biomass accumulations as well as growth habitat of Phanerochmete carysosporium were greatly influenced by soil type. Soil nitrogen content appears to be the primary factor responsible for differences in fungal growth in the three studied soils. Growth was strongly and positively correlated with nitrogen content. This factor, therefore, appears to play a major role in mediating the growth of the fungus in soil, and is easily controlled by nitrogen supplementation. The application of the fungus to treat contaminated soils will include small-scale treatment of selected pollutants at environmentally significant concentrations, the evaluation of amendments on primary and secondary metabolism, and the delivery of oxygen within the soil to the growing fungus. Ancillary investigations will look into the development of better estimates of fungal biomass in soil, the importance of soil sterilization to growth of the fungus, and inoculum development. (Lantz-PTT)
W90-05731

ARCTIC OIL SPILL RESPONSE GUIDE FOR THE ALASKAN BEAUFORT SEA.
Coast Guard Research and Development Center, Groton, CT.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-788. Price codes: A14 in paper copy, A01 in microfiche. Report No. CG-D-18-88, March 1988. 316p, 74 fig, 32 tab, 79 ref.

Descriptors: *Arctic zone, *Alaska, *Oil pollution, *Beaufort Sea, *Oil spills, *Cleanup operations, Management planning, Contingency planning.

This document describes equipment, techniques and logistics for responding to oil spills in the Alaskan Beaufort Sea. It is designed to serve as a planning guide which will help the US Coast Guard on-Scene Coordinator identify the steps and priorities for responding to major oil spills or oil well blowouts associated with petroleum activity off the northern coast of Alaska. Along with providing critical insight for developing an oil spill response strategy, this document discusses environmental factors which can contribute to the success or failure of an oil spill cleanup operation in arctic waters. Additionally, it provides a detailed description of the oil spill cleanup equipment in Alaska and outlines manpower requirements for its deployment and operation. (Author's abstract)
W90-05739

SUPERFUND RECORD OF DECISION: FRONTIER HARD CHROME, WA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-135313. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R10-85/014, July 1988. 29p, 7 fig, 1 tab.

Descriptors: *Water pollution treatment, *Superfund, *Water pollution sources, *Cleanup operations, *Groundwater pollution, Vancouver, Washington, Water pollution treatment, Chromium, Adsorption, Volatile organic compounds, Activated carbon, Costs.

The Frontier Hard Chrome (FHC) site, covering approximately one-half acre, is located in the City of Vancouver, Washington. The areal groundwater is used as the drinking water supply for the City of Vancouver, which has two well fields within one mile of the site. Since 1955, the site as primarily been occupied by two companies engaged in the chrome plating business. The facility is now being used as a storage and staging area for a neighboring business. In 1975, the City of Vancouver determined that the chromium in the wastewater from FHC was upsetting the operation of its new secondary treatment system. At that time, FHC began discharge of their untreated plating wastes to a dry well behind the facility. In 1976, the Washington State Department of Ecology permitted FHC to discharge to the dry well. In 1982, Ecology found FHC in violation of the Washington State Dangerous Waste Act for the illegal disposal of hazardous wastes, and in 1983 ordered FHC to stop discharging to the dry well. In December 1987, EPA published a Record of Decision for the site's first operable unit, which addressed the soil contamination. The second and final operable unit addresses chromium contaminated groundwater. The selected remedial action for this site includes: groundwater pump and treatment using selective media ion exchange to remove chromium, followed by carbon adsorption to remove volatile organic compounds with discharge into the river or the city sanitary sewer; groundwater monitoring; and implementation of institutional controls to restrict groundwater usage and to control new well drilling. The estimated present worth cost for this remedy is $3,800,000. (Lantz-PTT)
W90-05741

RETENTION, DETENTION, AND OVERLAND FLOW FOR POLLUTANT REMOVAL FROM HIGHWAY STORMWATER RUNOFF: INTERIM GUIDELINES FOR MANAGEMENT MEASURES.
Versar, Inc., Springfield, VA.
For primary bibliographic entry see Field 5D.
W90-05754

REVIEW AND EVALUATION OF CONTINGENCY PLANS FOR OIL AND HAZARDOUS SUBSTANCES IN THE UPPER GREAT LAKES REGION.
E-Tech, Inc., Naragansett, RI.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A205-209. Price codes: A10 in paper copy, A01 in microfiche. November 15, 1986. 268p, 10 fig, 9 tab, 9 append. DOA Contract DACW35-86-R-0046.

Descriptors: *Emergency planning, *Oil pollution, *Hazardous wastes, *Great Lakes, *Water pollution treatment, *Cleanup operations, Ice, Cold regions, Evaluation, Oil recovery.

A contingency plan review conducted for the Corps in 1979 by the St. Lawrence-Eastern Ontario Commission for handling oil and hazardous substance spills on the upper Great Lakes and their connecting channels was updated and reviewed. Special attention was given to cleanup and control methods described for ice conditions that may exist in the region in winter. A total of 50 federal, international, state, and private contingency plans was reviewed and evaluated as part of this project. In addition, a summary of equipment and personnel available for response in this region was prepared based on information collected from 49 private companies as well as the Canadian Coast Guard. A total of 13 plans present information concerning techniques to contain and recover oil in non-ice conditions. Representative diagrams from these plans are presented. Only four plans make any notations toward ice conditions, and most provide only a curt description of seasonal ice coverage. The exception to this is the plan developed by the Sault Ste. Marie Marine Safety Office which describes basics concerning oil recovery, storage, and disposal in ice conditions. Plans specifically to mitigate environmental damage are essentially nonexistent. Several plans provide specific oil recovery sites. Environmental sensitivity maps, present brief summaries of preferred cleanup methods for oiled shorelines. Most contingency plans in the region provide at least basic information concerning the resources needing protection. Nine plans also reference bird cleaning and hazing as a method of mitigating damage to wildlife. Methods to deflect oil in swift-flowing rivers are presented in ten plans. Disposal methods are summarized by type in the plans. Plans for specific spill scenario are generally lacking. Licensed disposal sites are, however, commonly listed. It assumed that if these sites are contacted, then the material will be disposed of properly. Other guidelines are not generally presented. In all (with the exception of the Sault Ste. Marie MSO plan), there appears to be a serious lack of information presented in these contingency plans concerning the collection and disposal of oil in ice conditions. (Lantz-PTT)
W90-05768

PROTECTION OF RIVER BASINS, LAKES AND ESTUARIES: FIFTEEN YEARS OF COOPERATION TOWARD SOLVING ENVIRONMENTAL PROBLEMS IN THE USSR AND USA.
For primary bibliographic entry see Field 6G.
W90-05772

STRATEGY OF WATER QUALITY PLANNING AND MANAGEMENT.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
A. V. L'vov, and A. K. Kuzin.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 5-36, 6 fig, 2 tab, 7 ref.

Descriptors: *Management planning, *Water pollution control, *Water quality management, Policy making, Water quality.

The uneven presentation in volume of the components of water quality control strategy (determination of goals, planning, plan realization and control) does not diminish the functioning importance of each of them. The leading component of the strategy, however, is the determination for goals. It is here that the question 'to be or not to be' is solved of whether the rivers, lakes, and bays are to be clean or whether they shall forever turn into sewage ditches and storage areas of malodorous poisonous waters. It is here that state wisdom, power, and will of a nation are displayed. Clean water is a full-fledged component of well-being and, for this reason, the selection of water protection goals is important within the framework of promoting general well-being. For more complete and comprehensive development of water protection programs, environmental protection has to be based on the ecosystem approach, the determination of water pollution sources has to be based on the mass balance approach, and the determination of water protection measure efficiency has to be based on a combination of the technological and basin approaches. The area of priorities has to be transferred to resource-saving technology, which is nature protective and economical at the same time. The coordination in the implementation of water protection measures for the realization of protection programs has to be combined with a functioning system of carefully thought out economic sanctions and stimuli. The development of a special fund, based on payments for sewage disposal, promises a double advantage: stimulation for cutting pollutant disposal and the formation of funds for implementation of intersectorial measures. Efficient water condition control should be based on the completeness, reliability, and economical nature of the information on sewage composition and properties, and surface water quality. This control should allow for the determination of the cause-effect relationship between pollution sources and water quality. (See also W90-05772) (Lantz-PTT)
W90-05773

MASS BALANCE APPROACH TO WATER QUALITY MANAGEMENT IN THE GREAT LAKES BASIN TRIBUTARIES.
Environmental Protection Agency, Chicago, IL. Region V.
L. E. Fink, and P. L. Wise.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 37-57, 1 fig, 4 ref.

Descriptors: *Great Lakes, *Mass balance, *Model studies, *Water pollution control, *Water quality

management, Fate of pollutants, Management planning, Monitoring, Path of pollutants.

The mass balance approach is a simple accounting scheme that allows one to identify, quantify, and control, where possible, all significant sources of a toxicant to a receiving water. Its application requires no new theories or principles. It does require a broader view, however, of what sources need to be addressed under the Clean Water Act (CWA). It also requires an understanding of the transport and fate of toxicants in lotic and lentic ecosystems, so that the appropriate limiting water body is identified. In addition an appreciation of the sources and magnitudes of the error and uncertainty associated with modeling of the load-concentration relationships, is necessary in order to include an appropriate margin of safety in the waste load allocation formula. The tools that will be used in mass balance modeling are the same basic tools successfully utilized for conventional pollutants. The success of the mass balance effort for toxic chemicals relies on the ability to successfully monitor these chemicals from diffuse sources at levels corresponding to loading rates of concern and in the ambient environment at concentrations at or near the Water Quality Standard (WQS). This will require the characterization of as yet untested or inadequately tested environmental pollutants so that appropriate WQS can be derived. Once protective WQS are derived, analytical methods with the appropriate limits of quantification can be developed. With such methods it should be possible to evaluate how well the models used to calculate load-concentration relationships match actual monitoring results after all significant sources are identified and quantified, and the sources controls under the waste load allocation are implemented. Feedback from this follow-up monitoring will allow the refinment of the loading and fate rate estimates, as well as the accuracy and precision of model predictions. The 1978 Great Lakes Water Quality Agreement between the United States and Canada underscores the unique and irreplaceable character of the Great Lakes ecosystem, making it all the more imperative that the total loadings of the most persistent and bioaccumulative of the toxic pollutants to the Great Lakes be reduced to the maximum extent practicable in the shortest time possible. (See also W90-05772) (Lantz-PTT)
W90-05774

WATER QUALITY MODELING AND DEVELOPMENT OF WATER PROTECTION PROGRAMS.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
Y. V. Yermenko, and G. A. Sukhorukov.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 58-100, 4 fig, 4 tab, 35 ref.

Descriptors: *Management planning, *Model studies, *Water pollution control, *Water quality management, Mathematical analysis, Mathematical models, Theoretical analysis.

Progress in the improvement of water quality formation models and the optimization of water protection measures may be characterized as a change from a static formulation of problems to dynamic ones, a change from the simplest single component models of water quality formation to multicomponent models that consider the processes of interference and transformation of substances in a body of water, and a change from a single criterion formulation of problems to a multicriteria approach. Such development of modeling technology is based on the need to provide tools that are adequate for actual water protection problems and at the same time are suitable for extensive use. To this, a whole number of scientific problems must be solved including: selection and improvement of the theoretical basis for the synthesis of program development control in the area of water protection; building a system of optimization models for the water protection complexes; and building a more improved system of water quality formation models that are convenient for inclusion in the program optimization process. Expansion of the concept of water protective measures, which leads to substantial complication of the models, has become important along with the qualitative change in the formulation of the optimization problems. These include, in the number of optimized variables, the characteristic set of production technology development, treatment technology (purification) and recovery of discharged water, as well as water supply technology, which significantly influences the amount of water in the water sources. Such an approach requires an examination of the processes for attaining the final product output objectives. (See also W90-05772) (Lantz-PTT)
W90-05775

PROCEDURAL-METHODOLOGICAL PROBLEMS OF INVESTIGATING PETROLEUM PRODUCTS IN CONTINENTAL SURFACE WATERS.
Hydrochemical Inst., Rostov-na-Donu (USSR).
For primary bibliographic entry see Field 5B.
W90-05779

RISK ASSESSMENT OF CHEMICALS IN THE ENVIRONMENT.
For primary bibliographic entry see Field 5C.
W90-05792

SELECTION OF SUBSTANCES REQUIRING PRIORITY ACTION.
Department of the Environment, London (England). Water Quality Div.
For primary bibliographic entry see Field 6B.
W90-05798

PESTICIDES IN THE AQUATIC ENVIRONMENT--DATA NEEDS FOR THEIR CONTROL.
Department of the Environment, London (England). Water Quality Div.
For primary bibliographic entry see Field 5B.
W90-05801

QUALITY ASSURANCE GUIDELINES FOR ORGANIC ANALYSIS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5A.
W90-05806

U.S. ENVIRONMENTAL PROTECTION AGENCY'S STRATEGY FOR GROUND WATER QUALITY MONITORING AT HAZARDOUS WASTE LAND DISPOSAL FACILITIES LOCATED IN KARST TERRANES.
Environmental Protection Agency, Washington, DC. Office of Health and Environmental Assessment.
For primary bibliographic entry see Field 5A.
W90-05807

FINAL PROGRAM PLAN: RESEARCH STUDY ON HORIZONTAL WELL DRILLING AND IN-SITU REMEDIATION.
Savannah River Lab., Aiken, SC. Technical Div.
D. S. Kaback, and B. B. Looney.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-000010. Price codes: A03 in paper copy, A01 in microfiche. Report No. DPST--88-346, February 22, 1988. 23p, 13 fig, 1 tab, 3 ref.

Descriptors: *Groundwater pollution, *Horizontal wells, *In situ treatment, *Water pollution treatment, Air stripping, Soil contamination, Vacuum extraction, Vadose zone, Volatile organic compounds.

Vacuum extraction and air stripping are new technologies that have broad application at sites of volatile organic contaminated soils and groundwater. These types of sites are very common across the United States. A research study to test the combined effect of both technologies in an in-situ setting is planned. Vacuum extraction has been demonstrated as an effective ~~technique to~~ remediate the vadose zone both at the Savannah River Plant (SRP) in Georgia, and at numerous sites across the country. Air stripping has also been demonstrated as an effective technique in an above-ground setting at SRP and across the country. However, it has not been tested as an in-situ method. The proposed research is on the leading edge of groundwater/vadose zone remediation technology and has great potential to impact available technology in this field. Plans call for installation of two horizontal wells one below the water table and one in the vadose zone, to test a combination of vacuum extraction and in-situ air stripping at a site with known volatile organic contamination of both soils and groundwater. The proposed research study has no potential for causing significant adverse environmental impact. The detailed program plan has been revised to incorporate comments received from the South Carolina Department of Health and Environmental Control (SCDHEC) on the proposal submitted in October of 1987. The final program plan is being submitted to SCDHEC as an attachment to the Underground Injection Well Permit Application. (Author's abstract)
W90-05809

VOLUNTEER LAKE MONITORING PROGRAM, 1987. VOLUME VI: SOUTHWESTERN ILLINOIS REGION.
Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
For primary bibliographic entry see Field 2H.
W90-05827

SPRAY DISPOSAL OF DREDGED MATERIAL IN LOUISIANA WETLANDS: HABITAT IMPACTS AND REGULATORY POLICY IMPLICATIONS.
Louisiana Sea Grant Coll. Program, Baton Rouge.
For primary bibliographic entry see Field 5E.
W90-05828

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM STATISTICAL AND ANALYTICAL SUPPORT CONTRACT: FINAL REPORT--VOLUME I.
Martin Marietta Environmental Systems, Columbia, MD.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-156640. Price codes: A04 in paper copy, A01 in microfiche. Report No. CBS/TRS 12/87, September 1987. 48p, 8 fig, 8 tab, 14 ref, 4 append. Chesapeake Research Consortium contract X-003321-02.

Descriptors: *Chesapeake Bay, *Data acquisition, *Hydrologic data, *Monitoring, *Water quality, Chlorophyll a, Data interpretation, Dissolved oxygen, Network design, Salinity, Statistical methods, Water sampling.

A statistical analysis framework was developed for detection of trends in Chesapeake Bay water quality attributable to pollution control management actions. A procedure for selecting among the many possible statistical methods appropriate for trend analysis of water quality data is presented. The analysis selection procedure is based on the characteristics of the data being analyzed and is applicable to both historical and Chesapeake Bay Program (CBP) water quality monitoring data. Based on the proposed analysis framework and graphical and tabular analyses of the CBP monitoring data, a preliminary evaluation of the sampling design of the CBP monitoring program is provided. The quality assurance/quality control (QA/QC) procedures applied to CBP monitoring data prior to analyses are described and recommendations on various aspects of collection and analysis of Chesapeake Bay water quality monitoring program data are made. For data analysis, the recommendations are: (1) additional refinements of the proposed analysis framework should be performed; (2) Main Bay stations located in the vicinity of tributaries should not be included in analyses characterizing mainstem water quality; (3) QA/QC procedures, including estimation of error rates, should be ap-

plied to data (both new and historical) before they are incorporated into the CBP database to ensure data are acceptable for public dissemination; and (4) information on exchange rates among dissolved and particulate nutrients, chlorophyll-a, and dissolved oxygen (DO) for both the water column and the sediments should be incorporated into analyses of CBP water quality monitoring data. For sampling design, the recommendations are: (1) rigorous evaluation of the CBP water quality monitoring program design; (2) as is being done, measurements of temperature, salinity, conductivity, DO, and pH should be taken at 2 m depth intervals for the above and below pycnocline layers, and DO and salinity measurements should be take at 1 m depth intervals within the pycnocline for the central region of the Bay to define DO and salinity isopleths as accurately as possible; and (3) data generators, to the degree possible, should be required to use similar data collection and measurement techniques. (Lantz-PTT)
W90-05829

NATIONAL STREAM SURVEY-PHASE I: QUALITY ASSURANCE REPORT.
Environmental Protection Agency, Washington, DC. Office of Acid Deposition, Environmental Monitoring, and Quality Assurance.
For primary bibliographic entry see Field 7A.
W90-05830

DETERMINING REFORESTATION AREA AND DISTRIBUTION FOR SALINITY CONTROL.
Water Authority of Western Australia, Perth. Surface Water Branch.
N. J. Schofield.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 1, p 1-19, February 1990. 7 fig, 3 tab, 29 ref.

Descriptors: *Forest hydrology, *Hydrologic budget, *Hydrologic models, *Model studies, *Reforestation, *Water pollution control, Data interpretation, Design criteria, Prediction, Regression analysis, Salinity control.

Two methods of estimating reforestation area for salinity control are described. The first method, a simple water balance model, has readily determinable parameters and sensitivity. Further parameter measurements are necessary to improve its reliability and applicability. The second method is based on regressions of observed water table reductions below reforestation on the area and density of reforestation. The regressions have high correlation coefficients and are statistically significant at the 0.1% level. A groundwater modeling approach to determine the optimum reforestation distribution was found to have extensive data requirements and involved assuming values for some key model parameters. Predictions should be checked in the field. The best current approach to reforestation design is to use the water balance model or experimental regressions to predict reforestation area, and then use the groundwater model to design the optimum reforestation layout. (Author's abstract)
W90-05835

DEVELOPMENT OF A BENTHIC INVERTEBRATE OBJECTIVE FOR MESOTROPHIC GREAT LAKES WATERS.
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W90-05852

CLADOPHORA INTERNAL PHOSPHORUS MODELING: VERIFICATION.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2H.
W90-05854

REGULATING CONTAMINATED SEDIMENTS IN AQUATIC ENVIRONMENTS: A HYDROLOGIC PERSPECTIVE.
Maryland Univ., College Park. Dept. of Geography.
For primary bibliographic entry see Field 5A.
W90-05865

HYDROLOGIC ANALYSIS FOR COASTAL WETLAND RESTORATION.
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 7A.
W90-05866

LAKE MANAGEMENT TECHNIQUES IN FLORIDA, USA: COSTS AND WATER QUALITY EFFECTS.
Florida Inst. of Tech., Melbourne. Dept. of Chemical and Environmental Engineering.
F. E. Dierberg, and V. P. Williams.
Environmental Management EMNGDC, Vol. 13, No. 6, p 729-742, November/December 1989. 2 fig, 6 tab, 9 ref.

Descriptors: *Eutrophic lakes, *Florida, *Lake management, *Lake restoration, Economic aspects, Management planning, Statistical analysis.

Economic evaluations of restored or enhanced lakes in Florida indicated gravity drawdown was the least expensive action, whereas effluent diversion was 10,000 times more costly on a per hectare basis, with the other lake treatment costs occurring in the following order: gravity drawdown < grass carp introduction < mechanical drawdown < aeration < stormwater control = drawdown-dredging < effluent diversion. Within a particular treatment category, the costs spanned approximately one and one half orders of magnitude. Contrary to the abundant cost data, which permitted an economic analysis, inappropriate statistical design and lack of commitment toward sampling Florida's restored lakes undermines attempts to understand long-term water quality responses to various enhancement techniques. Using lake Tohopekaliga as a case study, ordinary statistical tests produced contradictory and unreliable interpretations on the effectiveness of drawdown and phosphorus removal at sewage treatment plants in improving the trophic state index. This emphasizes the need for more robust statistical approaches and more detailed data collection in evaluating lake restoration activities. It is unfortunate for Florida's lake restoration program that quantitative conclusions based on inferential statistics, replete with tests of assumptions, is limited to very few lakes. (Author's abstract)
W90-05867

WATER QUALITY/WATER QUANTITY CONFLICTS IN CALIFORNIA.
McDonough, Holland and Allen, Sacramento, CA.
For primary bibliographic entry see Field 6E.
W90-05890

FILTRATION ACTIVITY OF A SERPULID POLYCHAETE POPULATION, FICOPOMATUS ENIGMATICUS (FAUVEL), AND ITS EFFECTS ON WATER QUALITY IN A COASTAL MARINA.
Cape Town Univ. (South Africa). Dept. of Zoology.
For primary bibliographic entry see Field 2L.
W90-05912

FATE OF FRESHWATER MUSSELS TRANSPLANTED TO FORMERLY POLLUTED REACHES OF THE CLINCH AND NORTH FORK HOLSTON RIVERS, VIRGINIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
R. J. Sheehan, R. J. Neves, and H. E. Kitchel.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 139-149, December 1989. 2 fig, 3 tab, 20 ref.

Descriptors: *Habitat restoration, *Mussels, *Rivers, *Stream biota, *Virginia, *Water pollution effects, Environmental effects, Mollusks, Mortality, Population reestablishment, Recolonization, Tennessee, Water pollution, Water quality.

The Clinch River in southwestern Virginia and eastern Tennessee contains roughly 45 species of freshwater mussels. However, environmental contaminants and toxic spills have eradicated mussels from a section of the river where the fauna was once diverse and abundant. Adult freshwater mussels (Unionidae) were translocated to reaches of the Clinch and North Fork Holston rivers in southwestern Virginia, where mussels had previously been eliminated by water pollution. A total of 3,872 adult mussels of seven species were translocated and monitored for up to four years. Annual declines of some species were roughly 10 %, whereas other species appeared to decline much more rapidly. Losses were attributed largely to the high natural mortality of the older mussels that were translocated, as little active or passive movement of mussels from the sites was detected. Some mortality of mussels moved to the Clinch River may have been related to continuing perturbations in water quality. Site selection and the use of both young and adult cohorts appear to be key factors in the successful translocation of mussels. (Mertz-PTT)
W90-05928

COPPER TOXICITY FOR BLUE-GREEN ALGAE WITH REFERENCE TO THEIR PHYSIOLOGICAL STATUS.
Humboldt-Univ. zu Berlin (German D.R.). Sektion Biologie.
For primary bibliographic entry see Field 2H.
W90-05938

URBAN STREAMS AS A PLACE TO LIVE (STADTBACHE ALS LEBENSRAUM).
Gesamthochschule Essen (Germany, F.R.). Inst. fuer Oekologie.
For primary bibliographic entry see Field 4C.
W90-06021

MAPPING OUT A PLAN TO PROTECT ARIZONA'S GROUNDWATER.
Arizona Dept. of Environmental Quality, Phoenix. Office of Water Quality.
D. Totman.
Water Engineering and Management WENMD2, Vol. 137, No. 11, p 24-26, November 1989.

Descriptors: *Arizona, *Environmental protection, *Groundwater quality, *Hydrologic maps, *Water pollution control, *Water pollution prevention, Administrative agencies, Computers, Geographic information systems, Management planning, Nitrates.

The Arizona Department of Environmental Quality (DEQ) is addressing the health threat posed by nitrates with a progressive groundwater protection program. Among other functions, the program is designed to monitor and reduce nitrate levels statewide. Assisting the DEQ in its efforts is a geographical information system using graphics software and running on a computer workstation with a 19-inch color monitor and an eight-color plotter. Data has been downloaded from the state land department's database into state topographic maps. Groundwater-quality data has also been downloaded, including nitrate levels obtained by field testing of wells. To map these levels, a hydrologist overlays the latest map with nitrate data. A program then transforms the point data, in this case, the well heads, into color-coded contours that estimate nitrate levels for the entire region. Using a menu of pull-down symbols, the hydrologists can also plot pollution sources, water levels in tested wells, location of public water supplies and land-use activities which affect the groundwater flow in given areas. As new test results come in, the maps can be updated using a 'mouse'. (Chonka-PTT)
W90-06030

GROWTH PATTERN AND MATURATION IN ARCTIC CHAR (SALVELINUS ALPINUS L.) OF LAKE WALENSTADT, SWITZERLAND.
Jagd- und Fischereiverwaltung des Kantons St. Gallen (Switzerland).
C. Ruhle.

Aquatic Sciences AQSCEA, Vol. 51, No. 4, p 296-305, 1989. 7 fig, 2 tab, 27 ref.

Descriptors: *Char, *Growth, *Lake fisheries, *Lake restoration, *Switzerland, Fish harvest, Lake Walenstadt, Limnology, Mature growth stage, Mountain lakes.

Within one decade the yield in arctic char fishery of Lake Walenstadt (Switzerland) has dropped from 1.7 kg/ha to 0.7 kg/ha. In the same period growth decreased by about 15%. The fish considered as 'degenerated dwarfed chars' by fisherman are supposed to mature at very young ages. The change of the growth pattern can be related to reoligotrophication of the lake and impoverishment of the food source. The hypothesis of inbreeding and early maturation raised by fisherman could not be substantiated. Compared to other arctic char populations in Switzerland maturation takes place at least one year later. (Author's abstract)
W90-06090

WATER QUALITY TRENDS OF THE UPPER OHIO RIVER FROM 1977 TO 1987.
Ohio State Univ., Columbus. School of Natural Resources.
For primary bibliographic entry see Field 5B.
W90-06102

DISSOLVED OXYGEN PROFILES AT MAJOR WASTEWATER DISCHARGES AND HYDROELECTRIC DAMS AND THE OHIO RIVER.
Kentucky Univ., Lexington. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-06103

FISHES OF THE OHIO RIVER.
Louisville Univ., KY. Water Resources Lab.
W. D. Pearson, and B. J. Pearson.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 181-187, December 1989. 3 tab, 46 ref.

Descriptors: *Fish populations, *Ohio River, *Water pollution control, Habitats, Siltation, Species diversity.

To date, 159 species of fishes (14 of them introduced by humans) have been reported from the Ohio River. Three native fishes (Acipenser fulvescens, Alosa alabamae, and Ammocrypta asprella) have apparently been eliminated from the river. The Ohio River fish community was severely affected by the siltation of clean gravel substrates, and the inundation of those substrates by the canalization of the river before 1927. In the past 20-30 years, populations of many species have increased, particularly in the upper third of the river. Some pollution-intolerant species which had disappeared from the upper reaches of the river between 1900 and 1950 have been returning since 1970 (e.g. Polyodon spathula, Hiodon tergisus, and Carpiodes velifer). A few pollution-tolerant species have declined in abundance since 1970 (e.g. bullheads and Ictalurus catus). The most abundant fishes in the lock chamber samples of 1957-87 were Notropis atherinoides, Dorosoma cepedianum, Aplodinotus grunniens, Notropis volucellus, and Ictalurus punctatus. The ongoing recovery of the Ohio River fish community should encourage us to take additional steps to protect the river from catastrophic spills of toxic materials and to reintroduce eliminated native fishes. (Author's abstract)
W90-06106

CHANGES IN FRESHWATER MUSSEL POPULATIONS OF THE OHIO RIVER: 1,000 BP TO RECENT TIMES.
Marshall Univ., Huntington, WV. Dept. of Biological Sciences.
For primary bibliographic entry see Field 6G.
W90-06107

SEPTIC SYSTEM DENSITY AND GROUNDWATER CONTAMINATION IN ILLINOIS: A SURVEY OF STATE AND LOCAL REGULATION.
American Planning Association, Chicago, IL.
T. Smith, and M. Ince.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-178545. Price codes: A06 in paper copy, A01 in microfiche. Report No. ILENR/RE-WR-89/08, March 1989. 139p, 5 fig, 8 tab, 4 append.

Descriptors: *Groundwater pollution, *Illinois, *Regulations, *Septic tanks, *Wastewater management, *Wastewater treatment, State jurisdiction, Wastewater disposal.

Regulations of on-site septic systems in Illinois and nationally are summarized and strategies to address local on-site sewage disposal problems are estimated. A survey of county planners and health officials in Illinois found widespread problems with septic systems although related environmental consequences have limited documentation. Failures of systems were reported by nearly every county surveyed, primarily due to unsuitability of soils for system, age of system, lack of maintenance, improper design, and improper installation. The survey found that Illinois counties experiencing rapid residential growth in unsewered areas were also experiencing problems with septic system failures and potential contamination of groundwater and surface water. Based on the findings of this report, the American Planning Association makes the following recommendations to help local governments design siting regulations for septic systems and soil absorption fields in Illinois: require site evaluations for soil suitability, limit septic system density to control the volume of septic tank discharges to groundwater, provide stricter and more actively enforced regulation along lakefront and riverfront areas, use state and regional data on sensitive aquifers to target local regulation of septic systems, and provide better enforcement of local sanitation and land-use codes. (Author's abstract)
W90-06162

EFFECTIVENESS OF AGRICULTURAL AND SILVICULTURAL NONPOINT SOURCE CONTROLS.
Jones and Stokes Associates, Inc., Bellevue, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-164203. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA 910/9-88-210, October 1988. 220p, 4 tab, 124 ref, 4 append.

Descriptors: *Agricultural runoff, *Forest management, *Nonpoint pollution sources, *Water pollution control, Fisheries, Monitoring, Water quality control.

This report summarizes state-of-the-art information in the Northwest on available nonpoint source (NPS) monitoring techniques for aquatic ecosystems. The document evaluates the potential to use ecosystem measures such as fish habitat improvements and riparian area quality to assess the effectiveness of NPS control. The four main objectives of the report are to: (1) inventory selected monitoring programs associated with best management practices implemented by agricultural and silvicultural resource management agencies, including programs that use only baseline monitoring; (2) summarize water quality and aquatic habitat parameters that have been monitored and the techniques that have been used; (3) evaluate the applicability of monitoring techniques, particularly those assessing aquatic habitat condition; and (4) recommend, based on experience of the region, appropriate elements of a monitoring program. (Author's abstract)
W90-06175

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 7--APPENDIX B (CONTD).
Battelle Pacific Northwest Labs., Richland, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-017371. Price codes: A99 in paper copy, A01 in microfiche. Report No. PNL--6851, Vol. 7, May 1988. 801 p. DOE Contract DE-AC06-76RL0-1830.

Descriptors: *Groundwater quality, *Hanford Site, *Monitoring, *Radioactive wastes, *Washington, Groundwater management, Inspection, Logging (Recording), Well construction, Well logs.

This appendix is one of nine volumes, and presents data describing monitoring wells completed at the Hanford Site during the fourth quarter of calendar year 1987 (October through December). The data in this volume of Appendix B cover the following wells: 299-W10-14, 299-W15-15, 299-W15-16, 299-W15-17, and 299-W15-18. The data are presented in the following order: well completion report/Title III inspection list, inspection plan, as-built diagram, logging charts, and drill logs. (Lantz-PTT)
W90-06178

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 5--APPENDIX B.
Battelle Pacific Northwest Labs., Richland, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-017372. Price codes: A99 in paper copy, A01 in microfiche. Report No. PNL--6851, Vol. 5, May 1988. 718 p. DOE Contract DE-AC06-76RL0-1830.

Descriptors: *Groundwater quality, *Hanford Site, *Monitoring, *Washington, Groundwater management, Inspection, Logging (Recording), Well construction, Well logs.

This appendix is one of nine volumes, and presents data describing monitoring wells completed at the Hanford Site during the fourth quarter of calendar year 1987 (October through December). The data in this volume of Appendix B cover the following wells: 299-W6-2, 299-W7-1, 299-W7-2, 299-W7-3, and, 299-W7-4. The data are presented in the following order: well completion report/Title III inspection list, inspection plan, as-built diagram, logging charts, and drill logs. (Lantz-PTT)
W90-06179

EVALUATION AND PREDICTION OF HENRY'S LAW CONSTANTS AND AQUEOUS SOLUBILITIES FOR SOLVENTS AND HYDROCARBON FUEL COMPONENTS. VOLUME I: TECHNICAL DISCUSSION.
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 7B.
W90-06183

ILLINOIS SELF-HELP CONSORTIUM FOR WATER AND WASTEWATER PROJECTS.
Illinois Community Action Association, Springfield.
C. W. Levesque.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-179552. Price codes: A04 in paper copy, A01 in microfiche. Report No. ILENR/RE-WR-89/09, March 1989. 48p, 5 append. Illinois Department of Natural Resources Contract WR-34.

Descriptors: *Illinois, *Public participation, *Wastewater management, *Wastewater treatment, *Water resources management, *Water treatment, Public policy, Water pollution control.

This report documents the development and proposed implementation of an initial self-help project for water and wastewater in Illinois. It describes the creation of a Self-Help Consortium composed of leading state agencies to test the application of self-help principles in developing water and wastewater systems in Illinois. The report includes a review of existing environmental programs with self-help components in other states, outlines self-help and its institutionalization within the New York State Self-Help Support System, proposes a similar structure for the delivery of self-help might be tested. The report also records the work under-

taken to develop the Illinois Self-Help Consortium and indicates future activities that it might undertake. A draft of the 'Inter-Agency Agreement for Program Development and Implementation' between nine disparate state and federal agencies and organizations which forms the backbone of the Illinois Self-Help Consortium is included. The report is recommended for individuals interested in both the concept of 'self-help' as well as the process by which program proposals are translated into extant initiatives. (Author's abstract)
W90-06192

RAPID DESTRUCTION OF ORGANIC CHEMICALS IN GROUNDWATER USING SUNLIGHT.
Sandia National Labs., Albuquerque, NM. Solar Thermal Collector Technology Div.
For primary bibliographic entry see Field 5D.
W90-06199

ROLE OF SUB-SURFACE CONTAMINANT FATE AND TRANSPORT MODELS FOR RCRA LAND BAN REGULATIONS.
Kuo and Associates, McLean, VA.
For primary bibliographic entry see Field 5B.
W90-06200

SUPERFUND RECORD OF DECISION: HASTING GROUND WATER/FAR-MAR, NE.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-182463. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD-88/017, September 1988. 25p, 3 fig, 6 tab.

Descriptors: *Cleanup operations, *Groundwater pollution, *Nebraska, *Soil contamination, *Superfund, *Water pollution control, *Water pollution sources, Carbon tetrachloride, Ethylene dibromide, In situ treatment, Monitoring, Sediment contamination, Vacuum extraction.

The FAR-MAR-CO subsite of the Hastings Ground Water Contamination site is located east of the City of Hastings, Nebraska. The site is owned by Farmland Industries, Inc., which acquired the property through a merger with FAR-MAR-CO, Inc. in 1967. The current and previous owners used various chemicals onsite for fumigation of stored grain. Contamination was discovered when complaints about water quality were received by the Nebraska Department of Health (NDOH). Subsequently, the NDOH and the Nebraska Department of Environmental Control began investigating widespread groundwater contamination in the Hastings area. Contaminated soil at the subsite is believed to be the result of accidental spills and may be the direct result of a 1959 grain dust explosion which damaged a fumigation tank system, releasing 997 gallons of fumigant. The primary contaminants of concern affecting soil and groundwater are carbon tetrachloride and ethylene dibromide (EDB). The selected remedial action for this site includes: in situ soil vapor extraction, utilizing vacuum extraction technologies; treatment of extracted vapor with an activated carbon system, if necessary; access restrictions; and implementation of an operation and maintenance program which includes soil, air and groundwater monitoring. Results of the groundwater monitoring will be used to develop a technical approach for plume management and evaluate the need for groundwater treatment in a subsequent record of decision. The estimated present worth cost for this remedial action is $2,526,000, which includes a projection of annual operation and maintenance costs for the five year operating period. Long-term operation and maintenance costs will depend on the success of the vapor extraction during the operating period. (Lantz-PTT)
W90-06207

SUPERFUND RECORD OF DECISION: ATCHISON/SANTA FE/CLOVIS, NM.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-182505. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-88/039, September 1988. 27p, 4 fig, 6 tab, 3 append.

Descriptors: *Cleanup operations, *New Mexico, *Santa Fe Lake, *Superfund, *Water pollution prevention, *Water pollution sources, Arsenic, Biodegradation, Chromium, Clovis, Dikes, Groundwater pollution, Industrial wastewater, Lead, Monitoring, On-site wastewater treatment, Organic compounds, Phenols.

The Atchison/Santa Fe (Clovis) Superfund site is located just south of the Atchison, Topeka and Santa Fe (ATSF) Railway switching yard in Clovis, New Mexico. The site is comprised of an approximately 26-acre playa lake (Santa Fe Lake) which has been owned by ATSF since the early 1900s. Wastewater from the washing of hopper cars used for hauling potash, cement, fertilizer, grain, and coke were disposed in the lake from 1962 to 1982. EPA and ATSF reached an agreement under an Administrative Order on Consent for ATSF to conduct an investigation of the lake area. The investigation included sampling of the lake water, the sediments at the bottom of the lake, the soils between the lake bottom and the water table, and the groundwater underlying the lake. The major concern at this site is the potential threat to groundwater. The primary contaminants of concern affecting the sediments, soil, surface water, and groundwater are metals including arsenic, chromium and lead, organics including phenols and inorganics. The selected remedial action for this site includes: construction of a run-on control dike and ditch system; evaporation of the water in Santa Fe Lake through a pump and spray sprinkler system; excavation and onsite treatment of the lake sediments through biodegradation; in situ biodegradation of contaminated soil followed by excavation and placement in the land treatment area; capping the land treatment area with a PVC liner and vegetated soil layer; grading and revegetation of the disturbed area; access restrictions; and groundwater and land treatment area monitoring. Additional action may be taken to remediate groundwater contamination if subsequent monitoring results indicate the need for action. The estimated present worth cost for this remedial action is $2,840,000. (Lantz-PTT)
W90-06208

PHASE I DIAGNOSTIC/FEASIBILITY STUDY COVENTRY LAKE, COVENTRY, CONNECTICUT, 1984.
Connecticut Dept. of Environmental Protection, Hartford. Water Compliance Unit.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-181663. Price codes: A06 in paper copy, A01 in microfiche. (1984). 109p, 15 fig, 17 tab, 52 ref, 2 append.

Descriptors: *Connecticut, *Coventry Lake, *Eutrophication, *Fate of pollutants, *Limnology, *Path of pollutants, *Water pollution control, *Water pollution sources, Algicides, Drawdown, Lake morphology, Nutrients, Water quality, Watershed management.

Coventry Lake, (Lake Waumgumbaug), is a recreational waterbody located in the town of Coventry, CT. A diagnostic/feasibility study as conducted to provide a detailed evaluation of the eutrophication process of Coventry Lake. Existing water quality conditions in the lake were examined during an intensive one year study of lake biology, water chemistry, and physical characteristics. Watershed characteristics associated with lake water quality were evaluated by examining land use information and watershed geological data, particularly soils information. Water quality conditions and watershed characteristics were interpreted, and the results were used to evaluate and recommend lake and watershed management alternatives for mitigating the eutrophication process. The study recommends watershed management to reduce further nutrient loading and overwinter drawdown to mitigate macrophyte problems. Algicides may be necessary to treat phytoplankton. (Lantz-PTT)
W90-06210

EVALUATION CRITERIA GUIDE FOR WATER POLLUTION PREVENTION, CONTROL, AND ABATEMENT PROGRAMS.
Department of the Army, Washington, DC.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-175459. Price codes: A06 in paper copy, A01 in microfiche. Report No. DA-TM-5-814-8, April 23, 1987. 145p, 12 fig, 48 tab, 168 ref, 3 append.

Descriptors: *Handbooks, *Management planning, *Wastewater treatment, *Water pollution control, *Water pollution prevention, *Water pollution treatment, Costs, Economic aspects, Municipal wastewater, Wastewater facilities.

The manual describes principles and procedures to be followed in formulating and conducting a water pollution prevention, control, and abatement program, and in planning facilities required for solution of water pollution problems. The manual provides guidance for selecting and applying proven technologies for wastewater treatment and for solids handling and disposal. Both capital expenditures and operating costs are outlined. While the manual is directed primarily toward handling of domestic wastewaters, system alternatives for handling special process wastes from munitions manufacture and processing, metal plating, washrack, photographic, laundry, hospital and other sources are also addressed. The manual includes technical and cost information needed for project decisions and supporting data. (Author's abstract)
W90-06211

COMPUTERIZED DATA-BASE SYSTEM FOR LAND-USE AND LAND-COVER DATA COLLECTED AT GROUND-WATER SAMPLING SITES IN THE PILOT NATIONAL WATER QUALITY ASSESSMENT PROGRAM.
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06234

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

SELECTION OF SUBSTANCES REQUIRING PRIORITY ACTION.
Department of the Environment, London (England). Water Quality Div.
For primary bibliographic entry see Field 6B.
W90-05798

LESSONS LEARNED FROM THE 1986 DROUGHT.
Hydrologic Engineering Center, Davis, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-091. Price codes: A04 in paper copy, A01 in microfiche. IWR Policy Study 88-PS-1, June 1988. 64p, 2 tab, 68 ref, append.

Descriptors: *Drought, *Emergency planning, *Management planning, Contingency planning, Information exchange, Water resources management.

A study was conducted to determine whether there is a need to modify current Corps of Engineers drought policy based on lessons learned during the 1985-86 drought in the southeastern United States. By gathering information from a variety of agencies and interests, a comprehensive view of the 1986 drought was gained. Information was obtained both by personal interviews and review of correspondence and documents. Three principal findings have been derived as follows: (1) Corps offices, in all regions of the country, could benefit from a revision of the current policy document which would reflect the lessons learned from the 1985-86 southeast drought and which provides guidance for developing drought contingency plans which are responsive to those lessons; (2) Corps authorities, responsibilities and assistance,

including that related to Federal Emergency Management Agency (FEMA), need to be more clearly described for the time when a drought progresses from a matter of concern to a disaster and possible Presidential declaration. Consideration should be given to establishing, as part of drought management, a federal interagency advisory group; and (3) a Corps sponsored two-day workshop during 1988 on 'Preparation of Drought Contingency Plans' would be a quick and effective way to transfer information on the lessons learned from the southeast drought to Corps district and division offices in other regions. (Lantz-PTT)
W90-05825

DECISION MAKING FOR MULTIPLE UTILIZATION OF WATER RESOURCES IN NEW ZEALAND.
Otago Univ., Dunedin (New Zealand). Dept. of Geography.
P. Ali Memon.
Environmental Management EMNGDC, Vol. 13, No. 5, p 533-562, September/October 1989. 1 fig, 29 ref.

Descriptors: *Decision making, *New Zealand, *Public policy, *Water resources development, *Water resources management, Clutha River, Economic aspects, Legal aspects, Water demand.

The Clutha is the largest river in New Zealand. The last two decades have witnessed major conflicts centered on the utilization of the water resources of the upper Clutha river. Hitherto, central government has been able to manipulate the water resources allocation process to its advantage because of a lack of clear separation between its two roles as a policy maker and developer. The conflicts that have manifested themselves during the last two decades over the Clutha should be seen as part of a wider public debate during the last two decades concerning resource utilization in New Zealand. There has been a political and economic policy shift in New Zealand towards minimizing the role of public intervention in resource allocation and major structural reforms in the relative roles of central and regional government in resource management. The significance of these changes pose important implications for the future management of the Clutha. (Author's abstract)
W90-05862

STATISTICAL POWER ANALYSIS CAN IMPROVE FISHERIES RESEARCH AND MANAGEMENT.
Simon Fraser Univ., Burnaby (British Columbia). Natural Reource Management Program.
For primary bibliographic entry see Field 7C.
W90-06109

EVALUATION PROCEDURES TECHNICAL APPENDIX. PHASE I (CENTRAL PUGET SOUND): SAMPLING, TESTING, AND TEST INTERPRETATION OF DREDGED MATERIAL PROPOSED FOR UNCONFINED, OPEN-WATER DISPOSAL IN CENTRAL PUGET SOUND.
Evaluation Procedures Work Group, Seattle, WA.
For primary bibliographic entry see Field 5E.
W90-06213

6B. Evaluation Process

UNCERTAINTY ANALYSIS FOR URBAN FLOOD DAMAGE REDUCTION BENEFITS: ATTITUDES AND PRACTICES OF CORPS OF ENGINEER ECONOMISTS.
Army Engineer Inst. for Water Resources, Fort Belvoir, VA.
S. A. Davis, S. J. Ratick, and M. Ballew.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-944. Price codes: A04 in paper copy, A01 in microfiche. IWR Paper 89-P-1, January 1989. 57p, 33 fig.

Descriptors: *Flood hazard, *Flood damage, *Flood benefits, *Cost-benefit analysis, Surveys, Flood insurance, Economic aspects.

In April 1988, the Institute for Water Resources (IWR) conducted a workshop on uncertainty in benefit analysis. The purpose of the workshop was to meet with district and division economists to discuss details of the IWR work unit, 'Uncertainty in Benefit Analysis.' The workshop allowed researchers a chance to discuss the project definition document and to solicit field input on where the research effort should be focused. The workshop allowed IWR to get an extensive response to a questionnaire and have an open discussion of the most critical issues related to the work unit. Notwithstanding the limitation of sample size, the questionnaire was found to be valuable for a first look at the relative importance of benefit categories, getting a perspective on resource allocation for economics tasks, getting the economists' perspective of the major sources of uncertainty, and determining current attitudes and practices of economists on ways of handling uncertainty in benefit analysis. The major findings of the questionnaire are: (1) the group conformed to the assumption that the greatest part of the benefits from flood damage reduction projects, in this case 80%, comes from existing inundation reduction benefits; (2) most of the effort for estimating benefits, in this case about 63%, goes into tasks related to computing existing inundation reduction benefits; (3) the economists in the group considered insufficient data to be the greatest source of uncertainty in benefit analysis, although faulty data, unreliable methods, and unanticipated changes in conditions were all found to be significant problems for various stages in the planning process; and (4) a large portion of the respondents indicated that they were already consistently using subjective expert opinion, performing sensitivity analysis for key variables, and using qualitative descriptions in reports to handle uncertainty. Use of all these methods can be expected to increase, and most of these people can be expected to consistently use graphic display of uncertainty. (Lantz-PTT)
W90-05764

REVIEW AND EVALUATION OF CONTINGENCY PLANS FOR OIL AND HAZARDOUS SUBSTANCES IN THE UPPER GREAT LAKES REGION.
E-Tech, Inc., Naragansett, RI.
For primary bibliographic entry see Field 5G.
W90-05768

RISK ASSESSMENT OF CHEMICALS IN THE ENVIRONMENT.
For primary bibliographic entry see Field 5C.
W90-05792

TOTAL INDEX OF ENVIRONMENTAL QUALITY AS APPLIED TO WATER RESOURCES.
Ceske Vysoke Uceni Technicke v Praze. Fakulta Jaderna a Fysikalne Inzenyrska.
J. Riha.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 363-378, 3 fig, 3 tab, 11 ref.

Descriptors: *Environmental quality, *Mathematical studies, *Risk assessment, *Water pollution control, *Water pollution sources, *Water resources development, Decision making, Mathematical analysis, Mathematical equations, Water resources management.

Experience gained in Czechoslovakia and in other countries has shown that crude oil accidents caused primarily by the failure of technical equipment and the human factor are the main cause of accidents resulting in the pollution of the hydrosphere with chemical substances. During the planning and design of a new water pollution control structure, including its technology and siting in a certain area, concern is with a decision making problem: the determination of the optimal choice of variant with regard to the site of many criteria. There are four main factors in the theory of decision making under conditions of: (1) certainty; (2) risk; (3) uncertainty; and (4) unknown factors. The first step of the solution is to choose between the application of the so-called real functions of partial benefit systems, e.g. from ecological relations and standards and monotonous functions expressing the tendency to risk. Mathematical proofs are presented for the claim that decision making: (1) has a tendency to risk when the function is convex; (2) has an aversion to risk when the function is concave; and (3) has a neutral tendency to risk precisely when the function is linear. The application of a multicriteria axiomatic multiattribute utility theory proceeds the assumption that the total quality of the environment for any given region is determined by the essential properties of the individual components of the environment. The quality of the individual components may be assessed using available analytical and diagnostic indicators. These indicators of quality will form a catalogue of criteria whose values are determined either exactly or by estimation, by experts. Utility can be defined as representing an overall evaluation of benefit and costs. Utility models are based on the assumption that the whole vector of relevant objectives can be translated by means of a weighting procedure into the master control of one unambiguous utility function. This assumption of explicit and known trade-offs between objectives is essential in multicriteria axiomatic multiattribute utility theory. (See also W90-05792) (Lantz-PTT)
W90-05795

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIPS AND TOXICITY ASSESSMENT IN THE AQUATIC ENVIRONMENT.
Environmental Protection Agency, Washington, DC. Office of Toxic Substances.
For primary bibliographic entry see Field 5C.
W90-05796

DYESTUFFS AND THE ENVIRONMENT--A RISK ASSESSMENT.
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
For primary bibliographic entry see Field 5B.
W90-05797

SELECTION OF SUBSTANCES REQUIRING PRIORITY ACTION.
Department of the Environment, London (England). Water Quality Div.
C. D. Byrne.
IN: Risk Assessment of Chemicals in the Environment. Royal Society of Chemistry, London, England. p 414-434, 8 fig, 4 tab, 15 ref, 2 append.

Descriptors: *Chemical properties, *Decision making, *Europe, *Priority pollutants, *Risk assessment, *Water pollution control, Aquatic environment.

There are approximately 100,000 chemical substances registered on the European market. Some of these substances have the potential to cause harm to the aquatic environment and the organisms that it supports. The problem faced by pollution controlling authorities is one of selecting from this large number of substances those chemicals which warrant some form of priority action. This chapter outlines a general selection scheme which can be used to identify priority aquatic pollutants in a wide range of circumstances. The scheme consists of a set of decision trees into which parameters appropriate to particular circumstances can be slotted. The identification of List I substances in the context of the European Economic Commission (EEC) Dangerous Substances Directive has been taken as an example of an appropriate use of the scheme, in order to illustrate its detailed workings. The proposed scheme does not attempt to model the fate of the substances in the environment, but identifies those combinations of properties and input which appear likely to have the potential to result in environmental problems. These combinations of properties and input are quantified using readily available data resulting in a set of look-up diagrams which can be easily used for deciding whether a substance should be considered for List I status. When applied to the European Community List of 129, comparison of the substances selected by the scheme with those currently classified as List I or under consideration of List I status, shows a marked correlation. If noth-

ing else, this demonstrates that the results it produces accord closely with current views about priority substances based on the subjective assessment and practical experience of environmental risk. (See also W90-05792) (Lantz-PTT)
W90-05798

HAZARD AND RISK ASSESSMENT AND ACCEPTABILITY OF CHEMICALS IN THE ENVIRONMENT.
Technical Univ. of Denmark, Lyngby. Lab. of Environmental Science and Ecology.
For primary bibliographic entry see Field 5C.
W90-05799

STUDIES ON THE FATE OF CHEMICALS IN THE ENVIRONMENT WITH PARTICULAR REFERENCE TO PESTICIDES.
Schering Agrochemicals Ltd., Essex (England).
For primary bibliographic entry see Field 5B.
W90-05800

PESTICIDES IN THE AQUATIC ENVIRONMENT--DATA NEEDS FOR THEIR CONTROL.
Department of the Environment, London (England). Water Quality Div.
For primary bibliographic entry see Field 5B.
W90-05801

MANAGEMENT OF EFFLUENTS/BY-PRODUCTS OF MULTI-PURPOSE FINE CHEMICAL MANUFACTURE.
Imperial Chemical Industries Ltd., Manchester (England). Organics Div.
For primary bibliographic entry see Field 5D.
W90-05802

INDUSTRIAL PROPERTY TRANSFER EVALUATIONS: LIMITING LIABILITY.
B and V Waste Science and Technology Corp., Philadelphia, PA.
D. S. Duffala, and M. Miller.
Water Environment & Technology, Vol. 1, No. 4, p 492-495, December 1989.

Descriptors: *Environmental effects, *Environmental impact statement, *Evaluation, *Industrial development, *Legal aspects, *Liability, *Waste disposal, Inspection, Property value.

Parties involved in commercial and industrial property transfers frequently require an environmental investigation of the property before business transaction decisions can be finalized. Such investigations, called property transfer evaluations, are necessary to clearly delineate potential liabilities associated with waste management practices. The method for conducting a property transfer evaluation is a phased approach. It consists of a background data review, a visual inspection, any required sampling and analysis, and a final report. The investor or financier is interested in protecting the property's collateral value and wants a realistic assessment of environmental conditions at the property. Investors also want to avoid liabilities associated with equitable subordination, which could occur when an investor assumes a day-to-day management role in facility operations. Facility owners and operators can limit the liabilities associated with a property transfer through a realistic compliance assessment and a comprehensive management program. Specific activities that should be included in this liability reduction program include a complete environmental compliance audit, waste minimization surveys, recycling/reuse/recovery studies, remedial or corrective action implementation, compliance and management monitoring, thorough recordkeeping, and employee training programs. (Mertz-PTT)
W90-05976

FURTHER DEVELOPMENT OF THE THEORY OF RELIABILITY OF HYDRAULIC STRUCTURES.
For primary bibliographic entry see Field 8A.
W90-06133

6D. Water Demand

USE OF THE DANUBE RIVER AND THE INTEGRATED GABCIKOVO-NAGYMAROS HYDRO DEVELOPMENT PROJECT.
For primary bibliographic entry see Field 8C.
W90-06134

WATER USE AND COAL DEVELOPMENT IN EASTERN MONTANA: WATER AVAILABILITY AND DEMANDS. APPENDIX A: COMPUTER PROGRAM DOCUMENTATION FOR PART VII, SECTION A: DEMANDS FOR WATER IN COOLING.
Montana State Univ., Bozeman. Dept. of Agricultural Economics and Economics.
A. Barr.
Available from the National Technical Information Service, Springfield, VA. 22161. Report No. 59, Appendix, (1984). 125 p.

Descriptors: *Available water, *Coal mines, *Computer programs, *Montana, *Water demand, *Water requirements, *Water supply, Costs, Water allocation, Water resources management, Water utilization.

A one-year, two-phase study was undertaken to assess the availability and demand for water in the coal region of eastern Montana. Data presented indicate that sufficient groundwater is available in eastern Montana to permit substantial amounts of coal development. The demand for water in coal development will depend in part on the cost of water to developers. For any given type of proposed coal conversion plant there is considerable flexibility in the extent of water use. Data collected for the numerical analysis of the project were of such a nature that they were best handled by computer. The main thrust of the computer system is to calculate the cost of building and maintaining an electric generator which uses cooling methods which are relatively economical in their use of water. These costs were calculated both in terms of dollars and cents and in terms of money per quantity of electricity generated. These costs were calculated over a wide range of conditions; ie., air temperature. The methods used to calculate a particular data field are described in the text which is divided by individual programs. For each field of output one or more equations is given to show the computations from its point of input to the point of output. Nearly all of the equations are given using the FORTRAN conventions to show algebraic operators. (See also W75-06478 and W75-06979) (Lantz-PTT)
W90-06177

HYDROGRAPHS FROM SELECTED OBSERVATION WELLS AND ANNUAL PUMPAGE FROM MUNICIPAL SUPPLY WELLS, 1950-86, SANTA FE, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06231

6E. Water Law and Institutions

USE OF EXPERIMENTAL ECOSYSTEM IN REGULATORY DECISION MAKING.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 5A.
W90-05861

WATER QUALITY/WATER QUANTITY CONFLICTS IN CALIFORNIA.
McDonough, Holland and Allen, Sacramento, CA.
S. L. Somach.
Natural Resources & Environment NRENEL, Vol. 2, No. 2, p 39-40,69-70, Fall 1986.

Descriptors: *California, *Water allocation, *Water law, *Water quality, *Water rights, *Water supply, Administrative agencies, Estuaries, River basin development, Water quality management, Water use.

Moderating the impacts of water quality regulation on water rights vested under state laws is the water resource management problem of the 1980s. Water quality degradation due to loss of dilution capacity, alteration in temperature, and reduction in dissolved oxygen levels commonly results from the construction of instream reservoirs, transbasin diversions, and consumptive use. This loss of water quality is not subject to point source discharge regulations such as the issuance of National Pollution Discharge Elimination System (NPDES) permits. Because the loss of water quality is directly related to a decrease in water volume, the owners of vested water rights are affected by any action taken to improve water quality. Water quality agencies are often poorly equipped to balance the public interest in water quality against rights to particular quantities of water which are vested under the constitutions and laws of the states. The Sacramento River delta in California is an example of the kind of legal conflicts that can arise when water use results in water quality degradation. The loss in volume of the river system due to upstream appropriations has reduced the quality of the water and allowed salt intrusion from San Francisco Bay. While the ultimate outcome of the case is not certain, the courts have held that vested water rights may be limited and qualified as necessary to maintain 'without project' quality of river systems. This approach may well lead to impairment of most water rights. Suggested solutions to the Delta problem include utilizing the law of prior appropriation as a mechanism for ensuring high quality for Delta users, or limiting further depletions by new appropriations. If the quality level obtained is inadequate to serve the public interest, water supplies can be augmented by acquisition of river flows for dilution of pollutants and repelling of salt intrusions by purchase or condemnation, with compensation to the vested right owner for loss of private rights in pursuit of a public interest. (Tappert-PTT)
W90-05890

EVOLUTION OF ESA CONSULTATIONS ON WESTERN WATER PROJECTS.
Office of the Solicitor (Interior), Denver, CO. Rocky Mountain Region.
M. Zallen.
Natural Resources & Environment NRENEL, Vol. 2, No. 2, p41-42,70-71, Fall 1986.

Descriptors: *Administrative regulations, *Endangered species, *Environmental policy, *Water law, *Water resources development, Fish conservation, River basin development, Water allocation, Water rights.

Section 7 of the Endangered Species Act (ESA) requires a Federal agency, when authorizing, funding, or carrying out any project, to ensure that its actions are not likely to jeopardize an endangered or threatened species or adversely modify their critical habitat. As a result, the ESA has become a major factor in virtually all new water projects, with the Fish and Wildlife Service (FWS) and the Army Corps of Engineers (Corps) providing consultation on a variety of projects. Early projects, such as the Grayrocks Project in Wyoming in 1977, pitted the FWS against development interests in order to preserve the critical habitat of the whooping crane in the Platte River basin. At about the same time the FWS was consulting on several Bureau of Reclamation (BR) projects in the Colorado River basin which threatened several endangered species of fish. Court issues revolved around the agency's authority to abrogate state water allocation procedures, methods of calculating minimum water flow rates, and the role of the Corps as a permitting agency in regulating water diversions. The need for cooperation among agencies, states, and developers led to the formation of the Upper Colorado River Basin Coordinating Committee (UCRBCC) in 1984. The UCRBCC, in conjunction with private conservation groups, has developed and implemented a series of proposals to balance the needs of endangered species with additional water development. As proof that the process is working, development and conservation interests have requested formation of a similar group for the Platte River basin. (Tappert-PTT)

W90-05891

6F. Nonstructural Alternatives

SPECIAL FLOOD HAZARD EVALUATION REPORT. PLEASANT CREEK: VILLAGE OF EVANS MILL, JEFFERSON COUNTY, NEW YORK.
Army Engineer District, Buffalo, NY.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A200-933. Price codes: A03 in paper copy, A01 in microfiche. November 1988. 18p, 1 fig, 3 tab, 2 plates, 4 ref.

Descriptors: *Flood control, *Flood plain management, Flood forecasting, Flood warning systems, Floods, Land use, New York, Pleasant Creek, Regulations, Snowmelt.

This report documents the results of an investigation to determine the potential flood situation along Pleasant Creek within the Village of Evans Mills, New York. Although flood insurance rate maps have been developed for the community, approximate analyses were used to delineate an approximate flood plain along Pleasant Creek. The area was thought to have low development potential at the time the maps were prepared. The area now, however, is experiencing residential development pressure resulting from the expansion of the nearby Fort Drum military complex and more detailed flood plain information is required by local officials to manage this development. The greatest potential and frequency for floods within the study area occurs in the early spring when rain combines with snow melt. Although cool, early spring temperatures are conducive to a slower rate of snow melt, spring floods do occur most years. The strategy to modify susceptibility to flood damage and disruption consists of actions to avoid dangerous, economically undesirable, or unwise use of the flood plain. Responsibility for implementing such actions rests largely with the non-Federal sector and primarily at the local level of Government. These actions include restrictions in the mode and the time of occupancy; in the ways and means of access; in the pattern, density, and elevation of structures and in the character of their materials; in the shape and type of buildings and in their contents; and in the appurtenant facilities and landscaping of the grounds. The strategy may also necessitate changes in the interdependencies between flood plains and surrounding areas not subject to flooding, especially interdependencies regarding utilities and commerce. Implementing mechanisms for these actions include land use regulations, development and redevelopment policies, flood-proofing, disaster preparedness and response plans, and flood forecasting and warning systems. (Lantz-PTT)
W90-06172

6G. Ecologic Impact Of Water Development

PROTECTION OF RIVER BASINS, LAKES AND ESTUARIES: FIFTEEN YEARS OF COOPERATION TOWARD SOLVING ENVIRONMENTAL PROBLEMS IN THE USSR AND USA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-129688. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/9-88/023, November 1988. 310 p. Edited by Robert C. Ryans.

Descriptors: *Environmental protection, *Estuaries, *Lakes, *River basins, *USSR, *Water pollution control, *Water resources management, Ammonia, Great Lakes, Nonpoint pollution sources, Toxicity, Water pollution effects, Water quality, Water quality control.

In 1987, the United States and the Union of Soviet Socialist Republics completed 15 years of cooperation in the field of environmental protection. Overviews are provided of joint activities in water planning and management, in protection and management of water quality in lakes and estuaries, and in effects of pollutants on aquatic organisms and ecosystems. Among the papers are discussions of water quality management strategies and modeling techniques for water protection (USSR) and of mass balance approaches and nonpoint agricultural measures in water quality management (USA). Other contributions address predictive models of water body conditions and problems in investigating petroleum pollution (USSR) and describe mesocosms for evaluating ecosystem health and water quality research in the Great Lakes (USA). Finally, papers are presented regarding ion exchange in fish and biotesting of aquatic environments (USSR) and describing aquatic toxicity methodologies and ammonia toxicity test methodologies and ammonia toxicity and metabolism in fish. (See W90-05773 thru W90-05784) (Author's abstract)
W90-05772

STRATEGY OF WATER QUALITY PLANNING AND MANAGEMENT.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
For primary bibliographic entry see Field 5G.
W90-05773

MASS BALANCE APPROACH TO WATER QUALITY MANAGEMENT IN THE GREAT LAKES BASIN TRIBUTARIES.
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5G.
W90-05774

WATER QUALITY MODELING AND DEVELOPMENT OF WATER PROTECTION PROGRAMS.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Kharkov (USSR).
For primary bibliographic entry see Field 5G.
W90-05775

IDENTIFICATION OF POLLUTANTS SUBJECT TO NONPOINT AGRICULTURAL MEASURES IN THE MAUMEE RIVER BASIN.
Purdue Univ., Lafayette, IN.
For primary bibliographic entry see Field 5B.
W90-05776

PRESENT STATE OF MODEL BANK FOR PREDICTING WATER BODY CONDITIONS.
Hydrochemical Inst., Rostov-na-Donu (USSR).
For primary bibliographic entry see Field 5A.
W90-05777

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. MAIN REPORT AND SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT.
Army Engineer District, Los Angeles, CA.
For primary bibliographic entry see Field 8A.
W90-05804

EVOLUTION OF ESA CONSULTATIONS ON WESTERN WATER PROJECTS.
Office of the Solicitor (Interior), Denver, CO. Rocky Mountain Region.
For primary bibliographic entry see Field 6E.
W90-05891

EFFECT OF BOAT MOORINGS ON SEAGRASS BEDS NEAR PERTH, WESTERN AUSTRALIA.
Western Australia Univ., Nedlands. Centre for Water Research.
For primary bibliographic entry see Field 4C.
W90-05897

REPRODUCTION OF THE AZOV-DON SHAD FOLLOWING REGULATION OF THE DON RIVER.
Azovskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva, Rostov-na-Donu (USSR).
For primary bibliographic entry see Field 8I.
W90-06018

LETHAL EFFECTS OF DRAINING ON BROWN TROUT. A PREDICTIVE MODEL BASED ON FIELD AND LABORATORY STUDIES.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon (France).
J. Garric, B. Migeon, and E. Vindimian.
Water Research WATRAG, Vol. 24, No. 1, p 59-65, January 1990. 8 fig, 7 tab, 15 ref.

Descriptors: *Ecological effects, *Model studies, *Reservoir operation, *Trout, *Water resources management, Chemical properties, Dissolved oxygen, France, Isere River, Physical properties, Suspended sediments.

During the draining of dams to remove the sediment from the reservoir drastic fish mortalities have been observed down-stream in the river. These mortalities are correlated with an increase of the suspended solids and ammonia concentrations in the water and a fall in dissolved oxygen concentration. A field study was carried out in the Isere River in France. Different chemical and physical parameters of water quality were recorded with simultaneous toxicity testing using water from the river during the draining process. The results obtained are considered as reference data allowing laboratory experimental conditions to be drawn up. This methodology enables the predictive model derived from laboratory surveys to be consistent with the observed environmental phenomenon. The only way to predict the lethal impact of dam draining on fish (brown trout) was to take into account the strong synergistic effect between suspended sediment and the drop in dissolved oxygen. (Author's abstract)
W90-06073

RESOURCE DEVELOPMENT AND CONSERVATION HISTORY ALONG THE OHIO RIVER.
Ohio State Univ., Columbus. School of Natural Resources.
S. L. Frost, and W. J. Mitsch.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 143-152, December 1989. 8 fig, 43 ref.

Descriptors: *Ohio River, *River basin development, *Water pollution sources, *Water resources development, Industrial development, Interstate commissions, Navigation, Water pollution.

The 1578 km-long Ohio River has a rich history of natural resource use and abuse, starting with the development of the river itself for navigational purposes. There is a rich early record of natural history studies by Bartram, Michaux, Lesueur, Rafinesque and others. The navigational use of the river began with snag pulling and has progressed to modern high-lift dams. Flood control, navigational use of tributaries, and canal-building have been water resource development projects of the past. Early industries that developed around the availability and abundance of coal, oil, natural gas, salt, iron ore, timber, and clay in the valley ultimately led to the more recent pottery, iron and steel, chemical, and power generation industries along the river and its tributaries. There were also major horticultural developments of apple orchards, wine vineyards, and even silk worm farms along the river and a modest button industry from the mussels in the river itself. The pollution of the Ohio River has been a concern for decades, and the involvement of the federal government and the establishment of interstate compacts have led to the development of significant understanding of the science of water pollution and to the general improvement of the river's water quality. (Author's abstract)
W90-06101

CHANGES IN FRESHWATER MUSSEL POPULATIONS OF THE OHIO RIVER: 1,000 BP TO RECENT TIMES.
Marshall Univ., Huntington, WV. Dept. of Biolog-

ical Sciences.
R. W. Taylor.
Ohio Journal of Science OJSCA9, Vol. 89, No. 5, p 188-191, December 1989. 3 tab, 19 ref.

Descriptors: *Mollusks, *Mussels, *Ohio River, *Water pollution control, Habitats, Populations, Species diversity.

Through the use of literature records and new data, it was possible to compile a list of species of freshwater mussels that inhabited the upper Ohio River (Ohio River Mile 0-300) around a thousand years ago. This information was derived from specimens found associated with Indian middens located along the banks of the Ohio. Analysis of these data indicates that at least 31 species of mussels were present in the river. Arnold Ortmann recorded 37 species from the same area as a result of his many years of collecting around the turn of the 20th century. Thirty-three species have been collectively documented as currently residing in limited numbers in the river. The number of species present has remained essentially unchanged through time. There have been, however, significant changes in species composition and total numbers of individual mussels present. Occasionally, healthy populations can be found presently but much of the upper Ohio River is devoid of mussel life. Several large-river species have become established in this reach of the river as a consequence of damming and the resulting increase in depth, greater siltation and slowed rate of flow. Seventeen species known to have previously inhabited the upper Ohio River are listed as presumed to no longer survive there. (Author's abstract)
W90-06107

UPDATE OF THE CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS (FY 89).
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. M. Engler, T. R. Patin, and R. F. Theriot.
Available from the National Technical Information Service, Springfield, VA. 22161. Miscellaneous Paper D-90-2, February 1990. Final Report. 32p, append.

Descriptors: *Dredging, *Environmental effects, *Research priorities, Corps of Engineers, Sediment contamination, Water pollution effects, Wetlands.

Before the early 1970s, there was limited knowledge of the environmental effects of dredging and dredged material placement. The Dredged Material Research Program (DMRP), which was conducted from 1973-1978, subsequently developed first-generation procedures for determining the environmental consequences of dredged material placement and developed new or improved methods for minimizing adverse effects. The Corps was given the lead responsibility for conducting the research since the Corps is responsible for maintaining over 25,000 miles of Federal channels and over 400 harbors involving the annual disposal of 250 to 300 million cu yds of dredged material. In addition, the Corps regulates the discharge of dredged and fill material in waters of the United States including ocean waters involving an additional 150-200 million cu yd annually. Although the Corps is responsible for and regulates dredged material placement, the regulations are based on environmental guidelines and criteria developed jointly by the Corps and the EPA. This report describes the major completed and ongoing program (1973 to the present) addressing environmental effects of dredging, disposal, and/or fill activities. These are: (1) Dredged Material Research Program (DMRP); (2) Field Verification Program (FVP); (3) Dredging Operations Technical Support (DOTS) Program; (4) Long-Term Effects of Dredging Operations (LEDO) Program; (5) Wetlands Research Program (WRP); and (6) Dredging Contaminated Sediment Work Unit of the Improvement of Operations and Maintenance Techniques (IOMT) Program. All of these programs are research, field demonstrations, or technology transfer efforts of the Environmental Laboratory of the US Army Engineer Waterways Experiment Station, Vicksburg, MS. Work is accomplished using contractual and in-house research and development capabilities. (Lantz-PTT)
W90-06203

ENVIRONMENTAL ASSESSMENT OF OVERFLOW DREDGING IN MOBILE BAY, ALABAMA.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
D. Clarke, and D. Imsand.
Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. Information Exchange Bulletin, Vol. D-90-1, February 1990. 7p, 4 fig, 1 tab, 13 ref.

Descriptors: *Alabama, *Bays, *Dredging, *Environmental effects, *Mobile Bay, Benthic environment, Deposition, Overflow.

The available evidence regarding overflow dredging operations in Mobile Bay supports a finding of minimal risk to bay habitats and organisms. Impacts due to deposition of overflow slurries would be limited to the channel side slopes and small areas of adjacent shallow bay bottoms. Recovery of benthic assemblages, encompassing newly recruited individuals of opportunistic species and pre-existing benthos able to vertically migrate up through thin overburdens of dredged material, would be rapid in affected habitats. If enhanced loading can be demonstrated from an economic standpoint, either by modification of existing equipment or improved dredging techniques, overflow dredging appears to be an environmentally acceptable option for future projects in the Mobile Bay system. Overflow operations in deeper estuaries, where dissimilar sedimentological and hydrodynamic conditions might create different dispersion and deposition patterns, should be treated as separate cases. Overflow dredging, however, deserves further consideration and study as a viable alternative for future dredging requirements. (Lantz-PTT)
W90-06204

7. RESOURCES DATA

7A. Network Design

USE OF MESOCOSMS IN EVALUATING THE HEALTH OF AQUATIC ECOSYSTEMS.
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
For primary bibliographic entry see Field 7C.
W90-05780

U.S. ENVIRONMENTAL PROTECTION AGENCY'S STRATEGY FOR GROUND WATER QUALITY MONITORING AT HAZARDOUS WASTE LAND DISPOSAL FACILITIES LOCATED IN KARST TERRANES.
Environmental Protection Agency, Washington, DC. Office of Health and Environmental Assessment.
For primary bibliographic entry see Field 5A.
W90-05807

RESEARCH PLAN FOR INTEGRATED ECOSYSTEM AND POLLUTANT MONITORING AT REMOTE WILDERNESS STUDY SITES.
Idaho National Engineering Lab., Idaho Falls. Center for Environmental Monitoring and Assessment.
For primary bibliographic entry see Field 5A.
W90-05810

ENVIRONMENTAL MONITORING MASTER SAMPLING SCHEDULE: JANUARY-DECEMBER 1989.
Battelle Pacific Northwest Labs., Richland, WA.
L. E. Bisping.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-007101. Price codes: A04 in paper copy, A01 in microfiche. Report No. PNL-6816, January 1989. 49p. DOE Contract DE-AC06-76RLO-1830.

Descriptors: *Columbia River, *Data acquisition, *Hanford Site, *Monitoring, *Radioactive wastes, *Scheduling, *Washington, *Water quality, *Water sampling, Drinking water, Groundwater pollution, Groundwater quality, Irrigation water, Monitoring wells.

Environmental monitoring of the Hanford Site is conducted by the Pacific Northwest Laboratory (PNL) for the US Department of Energy (DOE). This document contains the planned schedule for routine sample collection for calendar year 1989 for the Surface and Groundwater Environmental Monitoring Projects. The schedule includes routine groundwater sampling, but does not include samples that may be collected in 1989 to support special studies or special contractor projects, or for quality control. The sample type, number, frequency, and analyses performed are tabulated for such specimens as Columbia River water, onsite ponds, irrigation water, drinking water, and sediment, all for radiological analysis. For direct radiation measurements of the Columbia River shoreline, onsite roadways and railways, and inactive waste sites, the location, frequency and type of instrument are tabulated. Hanford groundwater monitoring wells are also identified and the frequency and type of analyses tabulated. (Lantz-PTT)
W90-05826

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM STATISTICAL AND ANALYTICAL SUPPORT CONTRACT: FINAL REPORT--VOLUME I.
Martin Marietta Environmental Systems, Columbia, MD.
For primary bibliographic entry see Field 5G.
W90-05829

NATIONAL STREAM SURVEY-PHASE I: QUALITY ASSURANCE REPORT.
Environmental Protection Agency, Washington, DC. Office of Acid Deposition, Environmental Monitoring, and Quality Assurance.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-125983. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA/600/4-88/018, April 1988. 206p, 15 fig, 31 tab, 56 ref, 4 append. EPA contract no. 68-03-3249 and 68-03-3246.

Descriptors: *Acid rain, *Data acquisition, *Hydrologic data, *Quality control, *Streams, *Water quality, *Water sampling, Management planning, Model studies, National Stream Survey.

The National Stream Survey-Phase I, conducted during the spring of 1986, was designed to assess quantitatively, the present chemical status of streams in regions of the eastern United States where aquatic resources are potentially at risk as a result of acidic deposition. A quality assurance program was implemented to ensure consistency in the collection and analysis of water samples and to verify the reported results. In addition, the quality assurance program provides data users with quantitative and qualitative documentation of the quality of the database in terms of representativeness, completeness, and comparability and the quality of the analytical results in terms of detectability, accuracy, and precision. This quality assurance report describes the major design and operational aspects of the quality assurance program and the final assessment of the quality of the National Stream Survey database. This report also describes sampling and analytical problems that occurred during the survey and the corrective actions implemented. The survey database is sufficiently representative and complete so that population estimates based on chemical characteristics can be computed and interpreted. There are only a few cases in which data interpretation may be limited by data quality in terms of detectability, accuracy, and precision. In most of these cases, the limitations affect only interpretation of measurements at low concentrations. A model-based approach to evaluating systematic errors is presented as an appendix. Suggestions for future surveys include performing on-site inspections of all operations earlier in the survey so that most potential problems can be identified before they affect data quality and modifying the procedures for preparation of synthetic audit sam-

ples to facilitate improved estimates of accuracy. (Author's abstract)
W90-05830

DETECTING ACID PRECIPITATION IMPACTS ON LAKE WATER QUALITY.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
J. C. Loftis, and C. H. Taylor.
Environmental Management EMNGDC, Vol. 13, No. 5, p 529-538, September/October 1989. 3 fig, 1 tab, 25 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Lakes, *Monitoring, *Network design, *Water pollution effects, *Water pollution sources, Environmental Protection Agency, Limnology, Model studies, Project planning, Statistical analysis.

The US Environmental Protection Agency is planning to expand its long term monitoring of lakes that are sensitive to acid deposition effects. Effective use of resources will require a careful definition of the statistical objectives of monitoring, a network design which balances spatial and temporal coverage, and a sound approach to data analysis. This study examines the monitoring objective of detecting trends in water quality for individual lakes and small groups of lakes. Appropriate methods of trend analysis are suggested, and the power of trend detection under seasonal (quarterly) sampling is compared to that of annual sampling. The simple univariate approach is a logical starting point for designing a monitoring network and specifying routine data analysis procedures. An in-depth understanding of cause-and-effect relationships, however, will require the application of more comprehensive methods such as multivariate statistical models; intensive studies of deposition, water quality hydrology, limnology, and biology at the watershed level; and detailed watershed modeling of multiple processes. A truly effective national lake quality monitoring program should include intensive surveys of 'typical' ecological systems in addition to periodic population surveys and routine monitoring of individual lakes. (Author's abstract)
W90-05860

REGULATING CONTAMINATED SEDIMENTS IN AQUATIC ENVIRONMENTS: A HYDROLOGIC PERSPECTIVE.
Maryland Univ., College Park. Dept. of Geography.
For primary bibliographic entry see Field 5A.
W90-05865

HYDROLOGIC ANALYSIS FOR COASTAL WETLAND RESTORATION.
Williams (Philip) and Associates, San Francisco, CA.
R. Coates, M. Swanson, and P. Williams.
Environmental Management EMNGDC, Vol. 13, No. 6, p 715-727, November/December 1989. 9 fig, 1 tab, 26 ref.

Descriptors: *California, *Marsh plants, *Water resources management, *Wetland restoration, *Wetlands, Comprehensive planning, Hydrology, Model studies, Project planning.

Increasing recognition of the value of tidal wetlands has led to interest in how to restore and enhance areas that have been modified by human activity. The policy of recognizing restoration or enhancement as mitigation for destruction of other wetlands is controversial. Once policy questions are separated from technical questions, the steps in a successful project are straightforward. Restoration projects at two sites in California (the Hayward Area Recreation District and the Tijuana Estuary) used a combination of empirical geomorphic relationships, numerical modeling, and verification with field observations. The objectives at the Hayward area were to: restore habitat, and maintain healthy pickleweed on levees as habitat for the endangered salt marsh harvest mouse. The objective at the Tijuana Estuary was to protect and restore a productive cordgrass tidal salt marsh. Experience with these and other projects indicate that successful projects include the following elements: (1) clear definition of biological objectives that can be translated to hydrologic objectives; (2) good definition of site topography and tidal regime; (3) analysis of physical and biological constraints and opportunities; (4) development of design alternatives using numerical computer models and empirical geomorphic relationships along with calibration and verification of models with field data; (5) selection and review of the preferred alternative; (6) field inspections by the design team during construction; and (7) postconstruction monitoring of biological and hydrological parameters. (Author's abstract)
W90-05866

SURVEILLANCE: THE FOUNDATION FOR CONTROL AND ELIMINATION OF DRACUNCULIASIS IN AFRICA.
WHO Collaborating Center for Research, Training, and Control of Dracunculiasis, Atlanta, GA.
F. Richards, and D. Hopkins.
International Journal of Epidemiology IJEPBF, Vol. 18, No. 4, p 934-943, December 1989. 1 fig, 1 tab, 33 ref.

Descriptors: *Dracunculiasis, *Epidemiology, *Human diseases, *Monitoring, *Water pollution control, Developing countries, Parasites, Public health, Sanitation, Surveillance.

The International Drinking Water Supply and Sanitation Decade has stimulated a movement to eradicate human infection with the helminthic parasite Dracunculus medinensis (dracunculiasis), whose victims are disabled for weeks or months during the painful emergence of one or more worms from beneath the skin. Each year, millions of people acquire this infection by drinking unclean water. Among the critical activities that are necessary for the elimination of dracunculiasis, one of the most fundamental is that of epidemiological surveillance. Surveillance activities play a key role in the strategy to target affected villages for improved water supplies and other control activities. Accurate surveillance data also stimulate interest and support for national eradication programs. Dracunculiasis is a condition with excellent characteristics for reporting through passive surveillance systems. However, active surveillance, as well as other innovative surveillance strategies, should be used to establish baseline information in those villages where cases occur, and later to monitor epidemiologically important indices needed to evaluate the progress of elimination efforts. (Author's abstract)
W90-05873

SUBLETHAL TOXICANT EFFECTS ON FISH FORAGING BEHAVIOR: EMPIRICAL VS. MECHANISTIC APPROACHES.
Iowa State Univ., Ames. Dept. of Animal Ecology.
For primary bibliographic entry see Field 5C.
W90-06054

STATISTICAL POWER ANALYSIS CAN IMPROVE FISHERIES RESEARCH AND MANAGEMENT.
Simon Fraser Univ., Burnaby (British Columbia). Natural Reource Management Program.
For primary bibliographic entry see Field 7C.
W90-06109

7B. Data Acquisition

ARTIFICIAL RAINFALL FOR PAVEMENT RUNOFF STUDIES.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05656

HYDRAULICS RESEARCH IN MOUNTAIN RIVERS.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 8B.
W90-05686

OBJECTIVE NEPHOLOGY.
ST Systems Corp., Lexington, MA.
For primary bibliographic entry see Field 2B.
W90-05712

GROUND TRUTH FOR OBJECTIVE EVALUATION OF AUTOMATED NEPHANALYSIS.
ST Systems Corp., Lexington, MA.
For primary bibliographic entry see Field 2B.
W90-05714

GOES SATELLITE DATA FOR AIMS.
ST Systems Corp., Lexington, MA.
For primary bibliographic entry see Field 7C.
W90-05715

DETECTION OF SUBSURFACE FLOW PHENOMENA BY SELF-POTENTIAL/GEOELECTRICAL AND THERMICAL METHODS.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-488. Price codes: A04 in paper copy, A01 in microfiche. International Symposium, Karlsruhe, West Germany, March 14-18, 1988. 48p.

Descriptors: *Instrumentation, *Groundwater movement, *Data acquisition, Geophysical methods, Symposium, Geoelectrical method, Thermical methods, Infrared imagery.

Geophysical methods can be useful tools for detection of leakages in dams and waste disposal. Self-potential/geolectrical and thermometrical technics as well as infrared imagery procedure are still under development in this field of application. Major problems concerning these methods are the reproducibility of the data and the elimination of noise effects. This symposium was planned to serve as an international exchange of knowledge and experiences concerning the application of the methods mentioned above for the detection of subsurface waterflow, especially in connection with leakages in dams and waste disposal sites. The main topics will deal with fundamental aspects, theory of methods, instrumentation, data acquisition, processing and interpretation as well as noise effects. This publication contains abstracts of 43 papers presented at the symposium. (Lantz-PTT)
W90-05771

FACTORS INFLUENCING EXPERIMENTAL CARCINOGENESIS IN LABORATORY FISH MODELS.
Oregon State Univ., Corvallis. Dept. of Food Science and Technology.
For primary bibliographic entry see Field 5C.
W90-05820

CHESAPEAKE BAY MAINSTEM MONITORING PROGRAM STATISTICAL AND ANALYTICAL SUPPORT CONTRACT: FINAL REPORT--VOLUME I.
Martin Marietta Environmental Systems, Columbia, MD.
For primary bibliographic entry see Field 5G.
W90-05829

AMPEROMETRIC FLOW INJECTION TECHNIQUE FOR DETERMINATION OF HYDROGEN PEROXIDE AND SULFUR(IV) IN ATMOSPHERIC LIQUID WATER.
Sao Paulo Univ. (Brazil). Dept. of Chemistry.
I. G. R. Gutz, and D. Klockow.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 335, No. 8, p 919-923, 1989. 3 fig, 1 tab, 41 ref.

Descriptors: *Acid rain, *Chemical analysis, *Hydrogen peroxide, *Pollutant identification, *Sulfur, *Water analysis, Atmospheric water vapor, Chemistry of precipitation, Detection limits, Flow injection system, Fog, Rain, Snow.

A sensitive, selective and fast method for the determination of hydrogen peroxide and sulfur(IV) present in atmospheric liquid phase is presented. The flow injection system used contains a specially designed electrochemical micro-cell. The necessary selectivity is achieved using an alkaline carrier flow for the oxidative determination of hydrogen peroxide and an acidic one for the bisulfite oxidation, and employing differential measurements before and after addition of catalase or sulfite oxidase, respectively. Samples of 200 microL volume can be injected at a rate of 30 per hour and the electroactive species be determined in the range from millimolar level down to the detection limit of 20 nano M/L. The S(IV) present as hydroxymethanesulfonate or in form of other carbonyl adducts is determined after a previous alkalinization of the sample to liberate the sulfite. The method has been tested with rain, snow, fog and cryo-sampled atmospheric water vapor. The time resolution is adequate to follow precipitation events. (Author's abstract)
W90-05834

DETERMINING REFORESTATION AREA AND DISTRIBUTION FOR SALINITY CONTROL.
Water Authority of Western Australia, Perth. Surface Water Branch.
For primary bibliographic entry see Field 5G.
W90-05835

AQUATIC INSECT ADULTS AS INDICATORS OF ORGANOCHLORINE CONTAMINATION.
Windsor Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5A.
W90-05848

COMPARISON OF SUSPENSATE AND BOTTOM STREAM SEDIMENT GEOCHEMISTRY AT A PB OCCURRENCE IN THE SHENANDOAH VALLEY ZN DISTRICT, NORTHWEST VIRGINIA.
George Washington Univ., Washington, DC. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W90-05856

COMPOSITION OF LIGNIN IN ESTUARINE SUSPENDED PARTICULATES AND THE DISTRIBUTION OF PARTICULATE LIGNIN IN ESTUARIES AS DETERMINED BY CAPILLARY GAS CHROMATOGRAPHY OF CUPRIC OXIDE OXIDATION PARTICLES.
Lancaster Univ. (England). Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2L.
W90-05910

LANTHANIDE LUMINESCENCE QUENCHING AS A DETECTION METHOD IN ION CHROMATOGRAPHY: CHROMATE IN SURFACE AND DRINKING WATER.
Vrije Univ., Amsterdam (Netherlands). Dept. of Analytical Chemistry.
M. Schreurs, G. W. Somsen, C. Gooijer, N. H. Velthorst, and R. W. Frei.
Journal of Chromatography JOCRAM, Vol. 482, No. 2, p 351-359, December 1, 1989. 5 fig, 2 tab, 19 ref.

Descriptors: *Chromates, *Chromium, *Drinking water, *Europium, *Gas liquid chromatography, *Laboratory methods, *Luminescence, *Pollutant identification, *Surface water, *Terbium, *Water analysis, *Water pollution, Chemical reactions, Detection limits, Lanthanides, Selectivity.

Dynamic quenching of europium (Eu(III)) and terbium (Tb(III)) luminescence by inorganic anions as a detection method in ion chromatography was investigated. To obtain a high luminescence intensity, lanthanide(III) complexes were formed with ligands which make indirect excitation of the ions possible. Tb-acetylacetone (acac) complexes are simply obtained by mixing equimolar solutions of Tb(III) and acac, and oxygen removal is not necessary. This method has a high inherent selectivity as only a few anions (e.g., nitrite, chromate) induce efficient dynamic luminescence quenching. Chromate was found to be an efficient quencher of terbium-acetylacetone luminescence. Epidemiological studies have indicated that chromium(VI) is carcinogenic in humans, and the World Health Organization has a limit of 50 ppb for chromate in drinking water. Samples of tap water and surface water, spiked with chromate, were injected into a high-performance liquid chromatographic system with post-column addition of the luminescent complex. In this way, a detection limit of 0.11 micromoles (13 ppb) of chromate was obtained, demonstrating the suitability of dynamic luminescence quenching as a detection method for chromate in water samples. (Author's abstract)
W90-05913

DETERMINATION OF ORGANIC AND INORGANIC ACIDS IN PRECIPITATION SAMPLES.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
For primary bibliographic entry see Field 5A.
W90-05914

SCALING THE SATURATED HYDRAULIC CONDUCTIVITY OF AN ALFISOL.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
For primary bibliographic entry see Field 2G.
W90-05916

COMPARISON BETWEEN ACETONE AND DIOXANE AND EXPLANATION OF THEIR ROLE IN WATER REPLACEMENT IN UNDISTURBED SOIL SAMPLES.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.
C. J. Chartres, A. J. Ringrose-Voase, and M. Raupach.
Journal of Soil Science JSSCAH, Vol. 40, No. 4, p 849-863, December 1989. 7 fig, 2 tab, 30 ref.

Descriptors: *Acetone, *Clays, *Dioxane, *Microscopic analysis, *Sample preparation, *Soil analysis, *Soil physical properties, *Soil structure, *Soil water, Infrared spectroscopy, Molecular structure, Polymers, Soil cement, Swelling, X-ray diffraction.

Undisturbed, moist samples from the A horizon of a swelling gray clay were treated with acetone or dioxane, with or without para-dichlorobenzene to replace soil water. They were then either impregnated with polyester resin while still solvent-wet or after drying. Structural changes in samples treated with dioxane and then impregnated while solvent-wet indicated little evidence of either disintegration or shrinkage resulting from the treatment. However, samples treated with acetone were prone to disintegration, but this was mitigated somewhat by the addition of para-dichlorobenzene. Allowing either solvent to evaporate before impregnation caused shrinkage. X-ray diffraction and infrared studies of treated clay separates indicated that dioxane prevented the marked swelling and potential dispersion found with acetone. It was concluded that dioxane breaks structural bonds within clay interlayers and between soil crumbs, thus limiting both collapses of clay minerals and sample shrinkage on drying. No changes to plasmic fabrics could be seen under a petrological microscope. Because of their appropriate size and shape, dioxane molecules could also enter clay interlayers, thus preventing marked shrink/swell movements. There is some indication that they may also form epoxide-like compounds that themselves form structural 'cements'. (Author's abstract)
W90-05918

EVALUATION OF A SKIMMER DREDGE FOR COLLECTING FRESHWATER MUSSELS.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
A. C. Miller, R. Whiting, and D. B. Wilcox.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 151-154, December 1989. 1 fig, 1 tab, 10 ref.

Descriptors: *Biological samples, *Dredging, *Mussels, *Samplers, Bottom sediments, Mississippi River, Mollusks, Mortality, Performance evaluation, Population density, Skimmer dredge, Species diversity, Surveys.

A skimmer dredge was used effectively to collect freshwater mussels from sand-silt substrate in the upper Mississippi River. The skimmer dredge used was a smaller version of a marine dredge without hydraulic jets. This dredge was made with 0.63 cm mild steel plate and weighed 34.5 kg. Runners were 10 cm wide and 105 cm long. The skimmer blade was 43 cm wide with a set of forward-pointing 0.6 cm diameter tines spaced 1.9 cm apart that extended 2.5 cm beyond the leading edge of the blade. The blade and ramp assembly could be adjusted to alter dredging depth. Effectiveness was determined by comparing the numbers of mussels collected by the dredge to the total number present. The dredge obtained 62.3 % of the mussels in its path and provided good estimates of species richness, diversity, and relative species abundance. It caused 10 % mortality of thin-shelled species but did not damage thick-shelled species. In suitable substrate the skimmer dredge is preferable to a brail for exploratory surveys. (Mertz-PTT)
W90-05929

MICRO-BIOASSAY FOR EPILITHON USING NUTRIENT-DIFFUSING ARTIFICIAL SUBSTRATA.
Cincinnati Univ., OH. Dept. of Biological Sciences.
G. G. Gibeau, and M. C. Miller.
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 2, p 171-176, December 1989. 1 fig, 3 tab, 24 ref. Grant NFS-DPP-83320544.

Descriptors: *Algae, *Artificial substrates, *Bioassay, *Grazing, *Invertebrates, *Nutrient requirements, *Periphyton, *Rivers, Antibiotics, Aquatic productivity, Arctic rivers, Nitrogen, Nutrient-diffusing substrata method, Nutrients, Organic substrates, Phosphorus, Pollutants, Porcelain, Silica.

A modification of the nutrient-diffusing substrata method was used to evaluate nutrient and invertebrate grazer effects on attached epilithic algae in the Kuparuk River, located on the North Slope of the Brooks Range, AK. An acid-cleaned porcelain or fused silica disk was melted into the opening of a small plastic, agar-filled vial, supplemented with water soluble materials. These materials were such that they would have an impact on the biomass and/or productivity of the autotrophic and/or heterotrophic communities colonizing hard surfaces in rivers and lakes. The vials were independent replicates (3-6/treatment), providing many more treatments per unit cost and unit effort than other methods currently employed. After 3 week incubation periods in the river, it was shown that this method worked very well, it was also demonstrated that the river was limited by phosphorus and nitrogen, thereby confirming the results of previous assays. The method would also allow for the use of nutrients, xenobiotics, antibiotics, and/or organic substrates to be used to enhance or minimize the effects on autotrophs or heterotrophs in complex communities. (Author's abstract)
W90-05931

SIMULATION OF VERTICAL LIMNOLOGICAL GRADIENTS.
Wyoming Univ., Laramie. Dept. of Zoology and Physiology.
For primary bibliographic entry see Field 2H.
W90-05935

SPECTROPHOTOMETRIC FIELD MONITOR FOR THE DETERMINATION OF NITRATE IN RIVER WATER: STATISTICAL ANALYSIS OF THE RESULTS FROM A NINE-MONTH FIELD TRIAL.
Freshwater Biological Association, Wareham (England). River Lab.
H. Casey, R. T. Clarke, S. M. Smith, J. R. Clinch, and P. J. Worsfold.

Analytica Chimica Acta ACACAM, Vol. 227, No. 2, p 379-385, December 15, 1989. 7 tab, 4 ref.

Descriptors: *Instrumentation, *Monitoring, *Nitrates, *Spectral analysis, *Spectrophotometry, *Statistical analysis, *Water analysis, Automation, Computers, Diurnal variation, Field tests, Hydrologic data collections, Rivers.

Nitrate levels were recorded for 9 mo in field tests on the River Frome, Dorset, England using a spectrophotometric nitrate monitor. The monitor sampled river water at 30-min intervals to give 48 results per day. The nitrate level in the sample was calculated by ratioing the means of the sample and standard signals and was output to a miniprinter together with the date and time. Automation and data presentation were controlled by a single-board microcomputer. For each analysis cycle, the software compared both the duplicate values for the sample and the duplicate values for the standard; if the difference between the duplicate values differed by more than 5% for either the sample or the standard, the results for that analysis cycle was rejected. At least one valid result was obtained on 92% of the days and a complete 30-min interval sampling record was obtained on 34% of the days. The overall mean of 8122 valid results taken during the 273-day field trial was 4.90 milligrams/L NO3-N compared with an overall mean of 4.60 milligrams/L NO3-N for a parallel manual sampling and laboratory analysis program of one sample per wk. With only one maintenance visit of 1 hr per wk and low reagent consumption, the automated monitor is cost effective relative to a manual sampling program and provides a much better profile of the change in nitrate concentration with respect to time. Daily distribution of means ranged from 3.51 to 5.56 milligrams/L NO3-N. (Geiger-PTT)
W90-05936

ACOUSTIC IMAGING OF SUBSURFACE FEATURES.
Oak Ridge National Lab., TN. Energy Div.
For primary bibliographic entry see Field 5E.
W90-05962

STUDIES ON THE TRANSFER OF HEAVY METALS BETWEEN SEDIMENTARY PHASES WITH A MULTI-CHAMBER DEVICE: COMBINED EFFECTS OF SALINITY AND REDOX VARIATION.
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W90-05968

AUTOMATIC MONITORING OF SHORT DURATION SNOWMELT EVENTS IN A NOVA SCOTIA HEADWATER STREAM.
Inland Waters Directorate, Moncton (New Brunswick). Water Quality Branch.
G. S. Howell, and T. A. Springer.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 145-153, July/August 1989. 6 fig, 6 ref.

Descriptors: *Acid rain, *Canada, *Hydrogen ion concentration, *Snowmelt, *Stream profiles, *Streamflow, *Water quality, Chlorine, Conductance, Nova Scotia, Precipitation, Streams, Water sampling, Water temperature.

A Montedoro-Whitney automatic water quality monitor equipped to measure pH, specific conductance, water temperature and chloride was installed in situ in Moose Pit Brook in May, 1987 and operated throughout the winter and spring of 1988. On numerous occasions throughout the winter and particularly during the month of February, extremely short duration pH depressions were measured. These episodes typically occurred during midday and were characterized by a rapid pH drop over 1 hour, followed by a 5 to 6 hour recovery period. These pH events were not consistently related to elevated air temperatures or precipitation events but were with few exceptions observed on days of high insolation, These data indicate that solar radiation can result in small snowmelt events even when air temperatures are below zero (degrees C) and that these episodes can in turn influence the pH of a dilute, low order stream. (Author's abstract)
W90-05987

FRACTIONAL PRECIPITATION OF HUMIC ACID FROM COLORED NATURAL WATERS.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
R. A. Bourbonniere, and T. van Halderen.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 187-198, July/August 1989. 4 fig, 5 tab, 14 ref.

Descriptors: *Acid rain, *Acid streams, *Bogs, *Canada, *Humic acids, *Water analysis, Chemical analysis, Hydrogen ion concentration, Interstitial water, Kejimkujik National Park, Metal complexes, Nova Scotia, Organic matter, Physical properties, Soil chemistry, Water quality.

Humic acid is usually defined in the soil and aquatic sciences as that fraction of base-soluble soil organic matter or dissolved organic matter which is insoluble in acid. Stepwise titration of bulk dissolved organic matter from four samples of bog pore water and stream water collected from Kejimkujik National Park, Nova Scotia were undertaken to study the fractional precipitation of humic acid. Three independent methods: dissolved organic matter analysis, absorbence measurements at 330 mn, and densityometry of photographic negatives of filters, were used to quanitfy the precipitation of humic acid. The dissolved organic matter of the water remaining after filtration (i.e., fulvic acid) of the titrated samples shows a general trend toward lower dissolved organic matter values as pH decreased, indicating a sequential precipitation of humic acid. Half of the humic acid that would be precipitable at pH 2.0 could be precipitated at pH values from 3.4 to 4.6. There was good agreement among the three methods for bog waters, but surface water from Moose Pit Brook samples had dissolved organic matter results that did not correlate with the other two methods. These preliminary results have implications for the stability of dissolved organic matter in waters that experience pH decreases, and for the capacity of dissolved organic matter to complex metals. (Mertz-PTT)
W90-05991

ACID-BASE ANALYSIS OF DISSOLVED ORGANIC MATTER IN SURFACE WATERS.
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
J. R. Kramer, P. Brassard, and P. V. Collins.
Water, Air and Soil Pollution WAPLAC, Vol. 46, No. 1-4, p 199-204, July/August 1989. 2 fig, 9 ref.

Descriptors: *Acid rain, *Acid water, *Acidity, *Alkalinity, *Mathematical studies, *Organic matter, *Water analysis, Canada, Chemical analysis, Hydrogen ion concentration, Inorganic carbon, Kejimkujik National Park, Nova Scotia, Organic acids, Organic carbon, Titration.

Detailed acid-base characteristics of dissolved organic matter can be obtained by applying linear programming techniques to quality titration data. If carbonato ions are present, they can be subtracted from the titration curve by measurement of dissolved inorganic carbon and carrying out the titration in a closed system. A mono-protic multisite model is developed to obtain a pK(acid)--concentration distribution. Dense and equal interval pH data are required for an accurate characterization. A computer driven titrimetric system is used to obtain the data. The technique is applied to dissolved organic carbon (> 15 mg C/L) samples from the Kejimkujik region, Nova Scotia. A calculation shows that the acidic (pH 4.6) dystrophic water can result from mixing 15 mg C/L of the organic acids with an initial inorganic system of about 75 microequivalents/L alkalinity. (Mertz-PTT)
W90-05992

SAMPLER FOR THE WATER-SEDIMENT INTERFASE (MUESTREADOR PARA LA INTERFASE AGUA-SEDIMENTO).
A. J. Marinelarena.
Limnobios, Vol. 2, No. 10, p 713-714, December 1989. 2 fig. English summary.

Descriptors: *Instrumentation, *Lentic environment, *Samplers, *Sediment-water interfaces, *Water sampling, Chemical analysis, Environmental gradient, Microenvironment, Microorganisms.

In lentic environments the waters immediately above the sediments are relatively still. The intense microbial activity which develops there causes microzones in which concentration gradients of chemicals and microorganisms are formed. A simple device, consisting of a tripod with a central 1-meter bar to which flexible tubes can be plugged in at different levels, permits easy sampling of waters close to the sediments. Using this sampler, it can be observed that between samples taken at 50 cm and at 1 cm above the sediment, the concentration of ammonium is doubled and the concentrations of oxygen and of nitrate are reduced by about half. These differences cannot be appreciated with a conventional sampler. (Chonka-PTT)
W90-06028

IN-HOUSE DESIGN AND CONSTRUCTION OF A SCADA SYSTEM.
Springfield Utility Board, OR. Water Operations and Engineering.
For primary bibliographic entry see Field 5F.
W90-06031

ANCHORAGE LAUNCHES NEW SCADA CONTROLS.
Ship Creek Treatment Facility, AK.
For primary bibliographic entry see Field 5F.
W90-06032

USE OF SELENASTRUM CARPICORNUTUM AND MICROFEAST AS FOOD FOR DAPHNIA PULEX.
North Texas State Univ., Denton. Dept. of Biological Sciences.
E. E. Price, T. F. Parkerton, and K. L. Dickson.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 1, p 59-66, January 1990. 1 tab, 1 fig, 14 ref.

Descriptors: *Bioindicators, *Daphnia, *Diets, *Laboratory methods, *Population dynamics, *Selenastrum, *Yeasts, Algae, Aquatic populations, Bioassay, Chlorophyta, Fertility, Optimal yield, Toxicology.

Recently Daphnia pulex has become increasingly popular as a toxicity test organism due to its apparently greater sensitivity to toxicants than Daphnia magna. As part of a program to develop a protocol to maximize D. pulex neonate production, studies were implemented with the following objectives: examination of the effect of stored (4 C) versus fresh S. carpicornutum algae on neonate production and use of an algal batch culture system; determination of a feeding level which maximizes neonate production; and examination of the effect of a yeast extract (Microfeast) addition to the optimum S. carpicornutum feeding concentration. Mean neonate production per brood for fresh versus stored (up to 5 weeks) food treatments was not significantly different. Mean number of neonates per brood increased as a function of increasing algal concentration until, at a concentration of 240,000 cells/mL/day, a decrease occurred. Neonate production was significantly affected by feeding level ($p < 0.0001$), and the optimum feeding levels were 120,000 and 150,000 cells/mL/day. Adults fed an algal concentration of 240,000 cells/mL/day gained the most weight. Supplemental cultures containing 150,000 cells/mL algae and 5 micrograms/mL/day Microfeast resulted in a significant increase in fecundity ($p < 0.001$) and adult weight ($p < 0.001$). (VerNooy-PTT)
W90-06037

PREFERENCE/AVOIDANCE TESTING OF WASTE DISCHARGES ON ANADROMOUS FISH.

For primary bibliographic entry see Field 5C.
W90-06052

ASSESSING RIVER WATER QUALITY BY MEANS OF MULTIFACTORIAL METHODS USING MACROINVERTEBRATES. A COMPARATIVE STUDY OF MAIN WATER COURSES OF BISCAY.
Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.
For primary bibliographic entry see Field 5A.
W90-06066

MICROCOMPUTER-BASED INSTRUMENTATION SYSTEM FOR ANAEROBIC WASTEWATER TREATMENT PROCESSES.
Washington Univ., Seattle. Dept. of Chemical Engineering.
W. R. Slater, M. Merigh, N. L. Ricker, F. Labib, and J. F. Ferguson.
Water Research WATRAG, Vol. 24, No. 1, p 121-123, January 1990. 2 fig, 11 ref. NSF Grant CES-8416150.

Descriptors: *Automation, *Computers, *Instrumentation, *Measuring instruments, *Wastewater facilities, *Wastewater treatment, Anaerobic digestion, Data acquisition, Gas chromatography.

A microcomputer-based system for monitoring and control of anaerobic wastewater treatment processes is described. Instrumentation includes a gas chromatograph that measures methane, carbon dioxide, hydrogen, and carbon monoxide concentrations in the gas phase every 2 min, a second gas chromatograph that measures volatile acids (1-to-4-carbon) every 12 min, and sensors for continuous measurement of temperature, pH, ORP and gas production rate. The hydrogen and carbon monoxide detection limits are less than 1 ppm. Nutrient and substrate feed rates can be varied in a preprogrammed manner to allow automated collection of transient-response data. Data are presented for experiments in which fluidized-bed reactor (for which the main carbon sources is butyrate) is subjected to multi-frequency binary variations in feed flow rate. (Author's abstract)
W90-06082

ANALYTICAL PROBLEMS ARISING FROM THE USE OF BROMIDE AND RHODAMINE WT AS CO-TRACERS IN STREAMS.
Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Coal Technology.
D. R. Jones, and R. F. Jung.
Water Research WATRAG, Vol. 24, No. 1, p 125-128, January 1990. 5 fig, 7 ref.

Descriptors: *Bromides, *Chemical analysis, *Dye releases, *Dyes, *Hydrodynamics, *Tracers, Data acquisition, Environmental tracers, Streamflow.

Bromide and the fluorescent red dye rhodamine WT were used as co-tracers to determine the hydrodynamic characteristics of an experimental stream. However, the presence of the dye caused a negative interference during the subsequent colorimetric analysis of bromide. Approximately two bromide atoms reacted with each molecule of rhodamine. The fixed stoichiometry of this reaction permitted the true concentration (in micromole units) of bromide to be determined from the simple relationship: true (Br) = apparent (Br) + 1.61 (rhodamine). Thus, bromide and the dye can be used together as co-tracers without having to carry out a time consuming pre-treatment step to remove the rhodamine WT prior to the determination of the bromide. Bromide proved to be a more reliable tracer than lithium ion or rhodamine WT in the stream that was studied. (Author's abstract)
W90-06083

WATER QUALITY IN RIVERS OF WESTERN SWITZERLAND: APPLICATION OF AN ADAPTABLE INDEX BASED ON BENTHIC INVERTEBRATES.
Conservation de la Faune, Saint-Sulpice (Switzerland).
For primary bibliographic entry see Field 5A.
W90-06087

ECOLOGY OF CILIATES IN RIVERWATERS: THE EVALUATION OF WATER QUALITY VIA CILIATES AND FILAMENTOUS BACTERIA.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5A.
W90-06088

LEAKY FILTERS: A WARNING TO AQUATIC ECOLOGISTS.
Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.
J. G. Stockner, M. E. Klut, and W. P. Cochlan.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 16-23, January 1990. 5 fig, 1 tab, 48 ref.

Descriptors: *Data acquisition, *Data quality control, *Filters, *Laboratory methods, *Membrane filters, Bacteria, Data interpretation, Limnology, Microbiological studies, Oceanography, Plankton, Pore size, Semipermeable membranes, Separation techniques, Viruses.

The retention characteristics of commonly used 0.2 micron nucleation-track (Nuclepore, Poretics), polymer (Millipore, Sartorius) and inorganic membrane (Anopore) filters were examined. Scanning electron micrographs of the filter surface showed many to contain large holes or pores, some 5 times larger than the manufacturer's stated nominal pore diameter. Electron micrographs of filtrates from both fresh and seawater samples contained a variety of organisms, including viruses, ultramicrobacteria, bacteria, phototrophic picoplankton, and larger nanophytoplankton and microphytoplankton (e.g. diatoms), passed through the large openings. Total particles in the size range 1.0-12.8, micron passing through the various 0.2 micron filters tested, ranged from 2.2 to 14.3%, with 'best' retention (> 97%) by the Anopore. Average particle retention for all 0.2 micron filters tested was 92.5%. Higher passage rates (lower retention) are predicted for even smaller (<1.0 micron) particles (prochlorophytes, bacteria, viruses) and investigators are urged to use care when using polycarbonate or matrix type filters for partitioning size fractions for chemical, physiological, and ecological work. Caution should be used when interpreting results, especially if separations have not been verified by microscopy, incubation, or culture. (Author's abstract)
W90-06110

EFFECTIVENESS OF AGRICULTURAL AND SILVICULTURAL NONPOINT SOURCE CONTROLS.
Jones and Stokes Associates, Inc., Bellevue, WA.
For primary bibliographic entry see Field 5G.
W90-06175

EVALUATION AND PREDICTION OF HENRY'S LAW CONSTANTS AND AQUEOUS SOLUBILITIES FOR SOLVENTS AND HYDROCARBON FUEL COMPONENTS. VOLUME I: TECHNICAL DISCUSSION.
Research Triangle Inst., Research Triangle Park, NC.
G. B. Howe, M. E. Mullins, and T. N. Rogers.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A188-571. Price codes: A05 in paper copy, A01 in microfiche. Report No. ESL-TR-86-66, Volume I, September 1987. Final Report. 86p, 16 fig, 19 tab, 49 ref.

Descriptors: *Chemical analysis, *Henrys Law, *Hydrocarbons, *Laboratory methods, *Path of pollutants, *Solvents, Air stripping, EPICS, Equilibrium Partitioning in Closed Systems, Fuel, Temperature.

Laboratory measurements of Henry's Law constants are reported for 51 chemicals, spanning a wide range of chemical structures and volatiles. A static headspace method (Equilibrium Partitioning in Closed Systems, referred to as EPICS) was used to measure Henry's Law Constant, with the standard batch air stripping method used as a check. An average precision of 5% was obtained for the EPICS runs, and the Henry's Law constants agreed reasonably well (within 10%) with the batch air stripping results and other reported experimental values. Measurements were conducted over a temperature range of 10-30 C, and the data were correlated with a temperature regression equation coupled with a temperature dependent error term based on 95% confidence limits. The aqueous solubilities of the study compounds were also determined via the shake-flask method at temperatures of 10,20, and 30 C. Finally, the results of this study were incorporated into a thermodynamic correlation (UNIFAC), based on chemical structure, which allows the prediction of Henry's Law constants and aqueous solubilities for a wide variety of pure compounds and mixtures in dilute aqueous solutions. Volume I, contains the technical discussion and tabulated values of Henry's Law constants and aqueous solubilities. (Author's abstract)
W90-06183

HEALTH AND ENVIRONMENTAL CHEMISTRY: ANALYTICAL TECHNIQUES, DATA MANAGEMENT, AND QUALITY ASSURANCE.
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5A.
W90-06190

HMR52 PROBABLE MAXIMUM STORM (EASTERN UNITED STATES): USERS MANUAL.
Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 2B.
W90-06193

COMPARISON OF SNOW GAUGES USED IN NORDIC COUNTRIES: CONTRIBUTION OF FINLAND TO WMO SOLID PRECIPITATION MEASUREMENT INTERCOMPARISON. PART I: SYSTEM DESCRIPTION.
Finnish Meteorological Inst., Helsinki.
S. Huovila, E. Elomaa, K. Leminen, B. Tammelin, and A. Tuominen.
Available from the National Technical Information Service, Springfield, VA. 22161, as N89-18975. Price codes: A04 in paper copy, A01 in microfiche. Meteorological Publication No. 9, 1988. 61p, 25 fig, 6 tab, 22 ref.

Descriptors: *Comparison studies, *Instrumentation, *Measuring instruments, *Rain gages, *Snow, Denmark, Finland, Norway, Precipitation, Sweden, Wind.

Instruments and methods used during a Nordic comparison of precipitation gages in Jokloinen, Finland, are described. The comparison is a part of the Solid Precipitation Measurement Intercomparison organized by the Commission for Instruments and Methods of Observation of the World Meteorological Organization (CIMO/WMO). Eighteen precipitation gages used by Denmark, Finland, Norway and Sweden were compared over a period of five years. The influence of wind on precipitation measurements and, particularly, on snow measurements and the performance of different wind shields on an open field was investigated. The wetting and evaporation losses of different gages as well as other sources of error were also evaluated. Detailed technical system description and schematic drawings are given for the various gages. A data collection system, which measures and saves data automatically, uses a PC and software developed specifically for the project using a QuickBasic compiler. Preliminary data on measurement errors are included. More statistical and scientific results will be published later by the participating countries and the WMO. (Author's abstract)
W90-06214

AUTOMATED METHOD FOR REPRESENTING, TRACKING AND FORECASTING RAIN FIELDS OF SEVERE STORMS BY CONVENTIONAL AND DOPPLER WEATHER RADARS.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W90-06238

7C. Evaluation, Processing and Publication

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON CHANNEL FLOW AND CATCHMENT RUNOFF: CENTENNIAL OF MANNING'S FORMULA AND KUICHLING'S RATIONAL FORMULA.
For primary bibliographic entry see Field 2E.
W90-05621

ONE-DIMENSIONAL MODELING OF MOVING RAINSTORMS.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W90-05625

EFFECTS OF HYETOGRAPH SHAPE ON DETENTION POND SIZING.
Dominion Engineering Resources, Newport News, VA.
For primary bibliographic entry see Field 2E.
W90-05626

SPATIAL RESOLUTION IN HYDROLOGIC MODELING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05641

TILT AT THE WINDMILL OF RUNOFF SIMULATION.
Missouri Univ.-Rolla. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05642

COMPARISON OF SOME RAINFALL-RUNOFF MODELS FOR NONLINEAR FLOOD FORECASTING.
Utsunomiya Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05643

PARAMETER ESTIMATION IN STOCHASTIC MODELS FOR 2-D SHALLOW WATER FLOW.
Technische Univ. Twente, Enschede (Netherlands). Dept. of Applied Mathematics.
For primary bibliographic entry see Field 2L.
W90-05649

LAGSTRUM AND NONLINEARITY OF HYDROLOGIC TIME SERIES.
Tamkang Univ., Taipei (Taiwan). Dept. of Water Resources and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W90-05650

STOCHASTIC MODELS IN HYDROMORPHOLOGY.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
For primary bibliographic entry see Field 2E.
W90-05652

PREDICTING STREAM VELOCITIES IN A NAVIGATION CHANNEL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05659

MANNING'S EQUATION AND VELOCITY DISTRIBUTION IN OPEN CHANNELS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05660

ANALYTICAL METHOD FOR COMPUTATION OF ROUGH BOUNDARY RESISTANCE.
Tri-State Univ., Angola, IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05667

BACKWATER COMPUTATION OF NATURAL RIVERS WITH EXTREME BANK OR FLOODPLAIN ROUGHNESS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2E.
W90-05673

MODEL-PROTOTYPE COMPARISONS OF BOUNDARY RESISTANCE IN A TWO STAGE CHANNEL.
Queen's Univ., Belfast (Northern Ireland).
For primary bibliographic entry see Field 8B.
W90-05675

FLOOD ROUTING MODELS AND THE MANNING N.
National Weather Service, Silver Spring, MD. Hydrologic Research Lab.
For primary bibliographic entry see Field 8B.
W90-05696

TRANSIENT CHANNEL FLOW ROUTING USING FIXED-POINT ITERATION METHOD.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.
For primary bibliographic entry see Field 8B.
W90-05700

GENERAL APPROACH TO SIMPLIFIED LINEAR ST. VENANT MODELS.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
For primary bibliographic entry see Field 2E.
W90-05701

FLUVIAL HYDRODYNAMIC AND SEDIMENT TRANSPORT MODEL FOR THE CHESAPEAKE BAY WATERSHED.
Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.
For primary bibliographic entry see Field 2J.
W90-05705

NUMERICAL SIMULATION OF TRANSIENT SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-05707

GOES SATELLITE DATA FOR AIMS.
ST Systems Corp., Lexington, MA.
C. F. Ivaldi.
IN: Objective Nephology. Report No. AFGL-TR-88-0109, April 15, 1988. p 72-97, 2 fig, 5 tab, 3 ref.

Descriptors: *Meteorology, *Data acquisition, *Satellite technology, *Computer programs, *Data storage and retrieval, Data interpretation, Computer models, Computers, Automation.

The Air Force Geophysics Laboratory (AFGL) has a continuing need for satellite sounding data for test and evaluation of temperature retrieval algorithms, and for temperature profiles for input into numerical weather prediction models. The Geostationary Operational Environmental Satellite (GOES) VISSR Atmospheric Sounder (VAS) provides sounding data on an operational basis. A capability to routinely receive, extract, and store GOES sounding data (excluding data ingest), GOES multispectral imagery, navigation data, and grid information has been established for the AFGL Interactive Meteorological System (AIMS). The necessary software has been developed and implemented to achieve this capability. The software is based on functional specifications drawn from system requirements for a fully-functional GOES groundstation. Software design and development and the application of some new concepts have been directed in three broad categories: data storage, data structures were defined for three data types; area directory, satellite; and navigation data. Based on these structures database management software was developed which in turn was utilized as foundation software by applications to perform data-specific functions. The concepts of areas and groups of areas were applied to provide an interrelationship among the three data types that is characterized by fast and efficient single-point access to any data source. In addition, a utility was developed to provide user-friendly configuration of multi-disk systems for storage of satellite data. Under data ingest, the real time ingest sequence was automated to provide continuous acquisition of GOES satellite data without cooperation operation intervention. This capability results from the coordination of the ingest sequence, scheduling software, macro-expander, and macro-generation programs. Finally, system requirements and specifications were generated for the communications aspect of GOES satellite data as it relates to AIMS. (See also W90-05712) (Lantz-PTT)
W90-05715

THREE-DIMENSIONAL CLOUD AND PRECIPITATION MAPPING.
ST Systems Corp., Lexington, MA.
For primary bibliographic entry see Field 2B.
W90-05716

AUTOMATED GLOBAL CLOUD CLIMATOLOGY.
ST Systems Corp., Lexington, MA.
For primary bibliographic entry see Field 2B.
W90-05717

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR CHERRY POINT, NC.
Naval Oceanography Command Detachment, Asheville, NC.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A203-627. Price codes: A99 in paper copy, A01 in microfiche. December 1988. 335p.

Descriptors: *Meteorological data, *Meteorology, *Hydrologic data collections, *Weather data collections, *Climatology, *North Carolina, Cherry Point, Wind, Precipitation, Weather, Snow, Clouds.

This data report consists of a six part statistical summary of surface weather observations at Cherry Point, North Carolina, for the years 1945 through 1986. The six parts are: (1) Weather Conditions/Atmospheric Phenomena, (2) Precipitation/Snowfall/Snow Depth, (3) Surface Winds, Part (4) Ceiling versus Visibility/Sky Cover, (5) Psychrometric Summaries, and (6) Station Pressure/Sea Level Pressure. (Author's abstract)
W90-05721

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR SOUTH WEYMOUTH, MA.
Naval Oceanography Command Detachment, Asheville, NC.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-124. Price codes: A99 in paper copy, A01 in microfiche. December 1988. 343p.

Descriptors: *Meteorology, *Meteorological data, *Hydrologic data collections, *Weather data col-

lections, *Climatology, *Massachusetts, South Weymouth, Wind, Precipitation, Weather, Snow, Clouds.

This data report consists of a six part statistical summary of surface weather observations at South Weymouth, Massachusetts, for the years 1945 through 1986. The six parts are: Part A--Weather Conditions/Atmospheric Phenomena, Part B--Precipitation/Snowfall/Snow Depth, Part C--Surface Winds, Part D--Ceiling versus Visibility/Sky Cover, Part E--Psychrometric Summaries, and Part F--Station Pressure/Sea Level Pressure. (Author's abstract)
W90-05722

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR LAKEHURST, NJ.
Naval Oceanography Command Detachment, Asheville, NC.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-204. Price codes: A14 in paper copy, A01 in microfiche. December 1988. 330p.

Descriptors: *Meteorological data, *Meteorology, *Hydrologic data collections, *Weather data collections, *Climatology, *New Jersey, Lakehurst, Wind, Precipitation, Weather, Snow, Clouds.

This data report consists of a six part statistical summary of surface weather observations at Lakehurst, New Jersey, for the years 1945 through 1986. The six parts are: Part A--Weather Conditions/Atmospheric Phenomena, Part B--Precipitation/Snowfall/Snow Depth, Part C--Surface Winds, Part D--Ceiling versus Visibility/Sky Cover, Part E--Psychrometric Summaries, and Part F--Station Pressure/Sea Level Pressure. (Author's abstract)
W90-05723

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR BERMUDA NAS.
Naval Oceanography Command Detachment, Asheville, NC.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-205. Price codes: A14 in paper copy, A01 in microfiche. December 1988. 326p.

Descriptors: *Meteorology, *Hydrologic data collections, *Weather data collections, *Meteorological data, *Climatology, *Bermuda, Wind, Precipitation, Weather, Snow, Clouds.

This data report consists of a six part statistical summary of surface weather observations at Bermuda Naval Air Station, for the years 1945 through 1986. The six parts are: Part A--Weather Conditions/Atmospheric Phenomena, Part B--Precipitation/Snowfall/Snow Depth, Part C--Surface Winds, Part D--Ceiling versus Visibility/Sky Cover, Part E--Psychrometric Summaries, and Part F--Station Pressure/Sea Level Pressure. (Author's abstract)
W90-05724

SUMMARY OF METEOROLOGICAL OBSERVATIONS, SURFACE (SMOS) FOR ALAMEDA, CA.
Naval Oceanography Command Detachment, Asheville, NC.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-123. Price codes: A99 in paper copy, A01 in microfiche. December 1988. 331p.

Descriptors: *Meteorology, *Hydrologic data collections, *Weather data collections, *Meteorological data, *Climatology, *California, Wind, Alameda, Precipitation, Weather, Snow, Clouds.

This data report consists of a six part statistical summary of surface weather observations at Alameda, California, for the years 1945 through 1986. The six parts are: Part A--Weather Conditions/Atmospheric Phenomena, Part B--Precipitation/Snowfall/Snow Depth, Part C--Surface Winds, Part D--Ceiling versus Visibility/Sky Cover, Part E--Psychrometric Summaries, and Part F--Station Pressure/Sea Level Pressure. (Author's abstract)
W90-05725

FLOOD BOUNDARIES AND WATER-SURFACE PROFILE FOR THE COMPUTED 100-YEAR FLOOD, SWIFT CREEK AT AFTON, WYOMING, 1986.
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-05743

GROUNDWATER LEVELS PORTALES AREA, NEW MEXICO, 1982-1987.
R. R. Cruz.
Available from Books and Open File Report Section, USGS Box 25425, Denver, CO 80225. New Mexico State Engineer Office Map No. GWL-PA-82/87, 1989. 1p, 1 map, 10 ref.

Descriptors: *Groundwater level, *Maps, *New Mexico, Hydrologic data, Groundwater budget, Ogallala Aquifer, Groundwater depletion, Groundwater recharge, Precipitation, Water demand.

One of a series of maps, prepared by the New Mexico State Engineer Office and the US Geological Survey, shows changes in groundwater levels over a 5-year period. Groundwater data were collected as part of the continuing federal-state cooperative observation well program in New Mexico. Hydrologic data are collected to determine short-term changes and long-term trends in groundwater levels, to relate these data to changes in storage, and to provide the database necessary for management of groundwater resources. The areas covered during the reporting period (1982-1987) are the Clovis, House and Portales areas; Harding and Mora Counties; and the Mimbres and Nutt-Hockett groundwater basins. The map shows rises and declines in groundwater levels from 1982 to 1987 and the 1987 depth to water. Groundwater from the Quaternary valley fill and the Ogallala Formation is the principal source of all water used in the Portales area. Total groundwater withdrawals in the area were about 178,000 acre-ft in 1985 and about 142,000 acre-ft in 1980. Estimated surface water withdrawals, not including stock pond evaporation, were 98 acre-ft in 1985 and 184 acre-ft in 1980. In 1931, about 300 wells irrigated approximately 8,850 acres; in 1985, about 95,000 acres of land were being irrigated, and computerized data existed for approximately 870 wells. Annual precipitation from 1970 through 1986 ranged from a low of 10.39 inches in 1970 to a high of 23.91 inches in 1984 at the Portales weather station. The total precipitation recorded for the period was 277.48 inches; the average annual precipitation was 16.32 inches. About 22%, or 61.13 inches, of the total precipitation occurred in the last 3-year period of 1984 through 1986. (Lantz-PTT)
W90-05745

MAJOR GEOHYDROLOGIC UNITS IN AND ADJACENT TO THE OZARK PLATEAUS PROVINCE, MISSOURI, ARKANSAS, KANSAS, AND OKLAHOMA--OZARK AQUIFER.
J. L. Imes.
Available from Books and Open File Report Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-711-E, 1990. 3p, 3 maps, 9 ref.

Descriptors: *Geohydrology, *Ozark Aquifer, *Groundwater resources, *Maps, *Missouri, *Arkansas, *Kansas, *Oklahoma, Geology, Groundwater movement, Hydraulic conductivity, Dolostone, Limestone, Permeability, Sandstones, Shales, Porosity.

An investigation of the geohydrologic system in the Ozark Plateaus province has been made as part of the Central Midwest Regional Aquifer System Analysis, a major study that encompasses parts of 10 States. This portion of the Atlas focuses on the Ozark aquifer, a geohydrologic unit within the Ozark Plateaus aquifer system underlying the Ozark Plateaus province. The hydraulic conductivity of the Ozark aquifer has been estimated from specific capacity data. The areas of greatest hydraulic conductivity are concentrated along an east-trending line passing through the St. Francois Mountains and parallel to the Missouri River, where the hydraulic conductivity may be as great as 0.001 and 0.0001 ft/sec, respectively. The hydraulic conductivity decreases to the south as small as 10 to the -8th power near the south boundary of the Ozark Plateaus aquifer system. The Ozark aquifer consists of a complex sequence of geologic formations of differing lithologies and varying permeability and porosity. The formations include dolostone, limestone, sandstone, chert, and shale with dolostone as the predominant rock type in most of the Ozark Plateaus province. Movement of water within an aquifer, assuming isotropic conditions, is perpendicular to the lines of equal hydraulic head and proportional to the hydraulic gradient. Generally, fresh water enters the Ozark aquifer by precipitation on the outcrop areas. Most of the water discharges into streams within relatively short distances, but some flows radially away from the Ozark Plateaus province toward surrounding regions containing saline groundwater. The limit of fresh water to the west of the Ozark Plateaus province is depicted by the 1,000 and 2,000 mg/L dissolved solids concentration lines that approximately parallel the western limit of the Ozark Plateaus aquifer systems. It is probable that a groundwater divide exists in the Boston Mountains between the Arkansas River to the south and the White and Buffalo Rivers to the north. The divide coincides with the transition zone between saline water and fresh water in northern Arkansas. North of the groundwater divide, water recharges the Ozark aquifer primarily via the overlying Mississippian limestone rocks and from precipitation in outcrop areas and flows toward the White and Buffalo Rivers. South of the divide, recharge to the aquifer is small due to the thick surficial confining the system. (Lantz-PTT)
W90-05746

HANFORD SITE GROUND-WATER MONITORING DATA LISTING, JANUARY 1 THROUGH MARCH 31, 1987.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W90-05752

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 4--APPENDIX A.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 8A.
W90-05766

MESOSCALE SEVERE WEATHER DEVELOPMENT UNDER OROGRAPHIC INFLUENCES.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W90-05769

STATION CLIMATIC SUMMARIES: EUROPE.
Air Force Environmental Technical Applications Center, Scott AFB, IL.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-331. Price codes: A18 in paper copy, A01 in microfiche. Report No. USAFETAC/DS-89/033, January 1989. 473p.

Descriptors: *Meteorological data, *Climatology, *Data collections, *Meteorology, *Europe, *Weather, Cloud cover, Temperature, Precipitation, Snow, Relative humidity, Vapor pressure, Dewpoint, Winds, Storms, Fog.

A collection of summarized monthly and annual climatic data for specific locations in Europe is presented. Summarized climatological elements are: percent frequency of occurrence of ceiling and

visibility; means, extremes, and number of days with specified values of temperature, precipitation, and snowfall; means of relative humidity, vapor pressure, dew point, pressure altitude, and cloud cover; prevailing wind direction, with mean and extreme speeds; and number of days with thunderstorms and fog. (Author's abstract)
W90-05770

USE OF MESOCOSMS IN EVALUATING THE HEALTH OF AQUATIC ECOSYSTEMS.
Wisconsin Univ.-Superior. Center for Lake Superior Environmental Studies.
S. J. Lozano.
IN: Protection of River Basins, Lakes and Estuaries: Fifteen Years of Cooperation toward Solving Environmental Problems in the USSR and USA. Report No. EPA/600/9-88/023, November 1988. p 191-206, 1 tab, 67 ref.

Descriptors: *Aquatic environment, *Bioassay, *Bioindicators, *Ecological effects, *Mesocosms, *Water pollution effects, Biological studies, Cycling nutrients, Pesticides, Species composition, Species diversity.

The ability to predict ecological effects of contaminants in aquatic ecosystems is a goal of environmentally concerned agencies. Single-species laboratory bioassays are an excellent method for quickly obtaining comparative toxicological information on survival, growth, and reproduction of aquatic organisms under stress from a contaminant. However, because the interactions between species and other biogeochemical factors are missing, extrapolation of laboratory results from single species tests to natural systems is difficult and unreliable. Alternatives to single species tests include microcosm, mesocosm, and macrocosm studies. Mesocosm studies combine field validation of single species tests with replication to achieve realism not possible in laboratory microcosms. Expected results for mesocosm studies include: (1) the loss of sensitive species due to the direct effect of the pesticides; (2) changes in species composition at all trophic levels; (3) changes in nutrient cycling; (4) replacement of k-strategist species with r-strategist, i.e., smaller, more reproductive species replace longer-lived, less focused species; (5) lower species diversity and increase of dominance; and (6) reduction in both size and lifespan for dominant species. (See also W90-05772) (Lantz-PTT)
W90-05780

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 6 -- APPENDIX B (CONTD).
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W90-05785

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 9 -- APPENDIX C.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2F.
W90-05786

ACID RAIN--MODELLING ITS RISKS TO THE EUROPEAN ENVIRONMENT.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W90-05793

ROCKY MOUNTAIN ACID DEPOSITION MODEL ASSESSMENT: ACID RAIN MOUNTAIN MESOSCALE MODEL (ARM3).
Systems Applications, Inc., San Rafael, CA.
For primary bibliographic entry see Field 5B.
W90-05831

LINEAR FLOOD ROUTING MODEL FOR RAPID FLOW.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
For primary bibliographic entry see Field 2E.
W90-05838

WHAT IS THE DISTRIBUTED DELAYED MUSKINGUM MODEL.
Polish Academy of Sciences, Warsaw. Inst. of Geophysics.
For primary bibliographic entry see Field 2E.
W90-05839

COMPARISON OF PARAMETRIC AND NONPARAMETRIC METHODS FOR RUNOFF FORECASTING.
Centro di Ricerca Idraulica e Strutturale, Milan (Italy).
For primary bibliographic entry see Field 2E.
W90-05840

CLADOPHORA INTERNAL PHOSPHORUS MODELING: VERIFICATION.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 2H.
W90-05854

WAVE PENETRATION IN HARBOURS BY THE FINITE-ELEMENT SERIES-EXPANSION METHOD.
Bologna Univ. (Italy). Dipt. di Fisica.
For primary bibliographic entry see Field 8B.
W90-05859

NEW PRACTICAL AID TO REGIONAL HYDROGEOLOGIC PLANNING: THE RUNOFF COEFFICIENT MAP.
Siena Univ. (Italy). Dipt. di Scienze delle Terra.
For primary bibliographic entry see Field 2E.
W90-05864

DEVELOPMENT OF A MIXED SOLUTION TECHNIQUE FOR A DYNAMIC RIVER QUALITY MODEL.
Salford Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-05870

3-D FINITE ELEMENT TRANSPORT MODELS BY UPWIND PRECONDITIONED CONJUGATE GRADIENTS.
Padua Univ. (Italy). Dipt. di Metodi e Modelli Matematici per le Scienze Applicate.
For primary bibliographic entry see Field 5B.
W90-05882

MODELLING OF SOME ELLIPTIC FLUID MECHANICS PROBLEMS BY THE BOUNDARY ELEMENT METHOD.
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05884

SELECTIVE LUMPING EFFECTS ON DEPTH-INTEGRATED FINITE ELEMENT MODEL OF CHANNEL FLOW.
Mississippi Univ., University. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 2E.
W90-05885

USING SUPERCOMPUTERS FOR THE TIME HISTORY ANALYSIS OF OLD GRAVITY DAMS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
For primary bibliographic entry see Field 8A.
W90-05886

MULTI-COMPARTMENTAL MODELLING FOR AQUIFER PARAMETER ESTIMATION USING NATURAL TRACERS IN NON-STEADY FLOW.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 2F.
W90-05887

PREDICTION OF TRANSMISSIVITIES, HEADS, AND SEEPAGE VELOCITIES USING MATHEMATICAL MODELING AND GEOSTATISTICS.
Calvin Coll., Grand Rapids, MI. Dept. of Engineering.
For primary bibliographic entry see Field 2F.
W90-05888

TRENDS IN PARTICULATE DEPOSITION AND PRECIPITATION CHEMISTRY AT LEEDS (U.K.) 1907-1987.
Leeds Univ. (England). Dept. of Fuel and Energy.
For primary bibliographic entry see Field 5B.
W90-05900

RAINWATER COMPOSITION IN ATHENS, GREECE.
Athens Univ. (Greece). Lab. of Climatology.
For primary bibliographic entry see Field 5B.
W90-05901

INFLUENCE OF ATMOSPHERIC TRANSPORT ON PRECIPITATION CHEMISTRY AT TWO SITES IN THE MIDWESTERN UNITED STATES.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-05902

SCALING THE SATURATED HYDRAULIC CONDUCTIVITY OF AN ALFISOL.
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
For primary bibliographic entry see Field 2G.
W90-05916

SOURCES AND ROUTING OF THE AMAZON RIVER FLOOD WAVE.
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2E.
W90-05949

SENSITIVITY ANALYSES OF BIODEGRADATION/ADSORPTION MODELS.
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-05955

AERATION-BASIN HEAT LOSS.
Braun (C.F.) and Co., Alhambra, CA.
For primary bibliographic entry see Field 5D.
W90-05957

APPLICATION OF DECLINING RATE FILTRATION THEORY: CONTINUOUS OPERATION.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-05958

TWO-DIMENSIONAL MIXING IN RIVERS WITH UNSTEADY POLLUTANT SOURCE.
Ryerson Polytechnical Inst., Toronto (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-05960

PHYTOPLANKTON BLOOMS IN THE OLIGOTROPHIC OPEN SOUTH ADRIATIC WATERS.
Biological Inst., Dubrovnik (Yugoslavia).
For primary bibliographic entry see Field 2L.
W90-05966

CONSERVATIVE MIXING IN ESTUARIES AS AFFECTED BY SORPTION, COMPLEXING AND TURBIDITY MAXIMUM: A SIMPLE MODEL EXAMPLE.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 2L.
W90-05971

APPLICATION OF HYDROLOGICAL MODEL TO ACIDIFIED WATERSHEDS: A STUDY ON MERSEY RIVER AND MOOSEPIT BROOK, NOVA SCOTIA.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W90-05998

USE OF HISTORICAL INFORMATION FOR SELECTING A SAMPLE FROM A POPULATION OF LAKES.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W90-06001

HARMONIC ANALYSIS OF TIDAL MODEL TIME SERIES,
Institute of Ocean Sciences, Sidney (British Columbia).
For primary bibliographic entry see Field 2L.
W90-06023

HARMONIC STRUCTURE OF ENGLISH CHANNEL/SOUTHERN BIGHT TIDES FROM A WAVE EQUATION SIMULATION.
Skidaway Inst. of Oceanography, Savannah, GA.
For primary bibliographic entry see Field 2L.
W90-06024

FINITE ELEMENT STUDY OF TIDAL FLOW DATA FOR THE NORTH SEA AND ENGLISH CHANNEL.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-06025

FINITE DIFFERENCE SIMULATION MODEL OF TIDAL FLOW IN THE ENGLISH CHANNEL AND THE SOUTHERN NORTH SEA.
Rijkswaterstaat, The Hague (Netherlands). Div. of Tidal Waters.
For primary bibliographic entry see Field 2L.
W90-06026

RESIDUES OF 1-NAPHTHOL IN SOIL AND WATER SAMPLES IN AND AROUND BHOPAL, INDIA.
Industrial Toxicology Research Centre, Lucknow (India). Pesticide Toxicology Lab.
For primary bibliographic entry see Field 5B.
W90-06038

HEAVY METALS IN THE EASTERN OYSTER, CRASSOTREA VIRGINICA, OF THE MISSISSIPPI SOUND.
Gulf Coast Research Lab., Ocean Springs, MS. Analytical Chemistry Section.
For primary bibliographic entry see Field 5B.
W90-06041

STATISTICAL MODELS FOR THE ESTIMATION OF NET PHOSPHORUS SEDIMENTATION IN LAKES.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
For primary bibliographic entry see Field 2H.
W90-06085

STATISTICAL POWER ANALYSIS CAN IMPROVE FISHERIES RESEARCH AND MANAGEMENT.
Simon Fraser Univ., Burnaby (British Columbia). Natural Reource Management Program.
R. M. Peterman.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 1, p 2-15, January 1990. 9 fig, 2 tab, 80 ref.

Descriptors: *Data interpretation, *Fish management, *Fisheries, *Research, *Sampling, *Statistical analysis, *Statistics, Null hypothesis, Sample size, Sampling variability, Statistical methods, Type II error.

Ninety-eight percent of recently surveyed papers in fisheries and aquatic sciences that did not reject some null hypothesis (H sub 0) failed to report Beta, the probability of making a type II error (not rejecting H sub 0 when it should have been), or statistical power (1-Beta). However, 52% of those papers drew conclusions as if H sub 0 were true. A false H sub 0 could have been missed because of a low-power experiment caused by a small sample size or large sampling variability. Costs of type II errors can be large (for example for cases that fail to detect harmful effects of some industrial effluent or a significant effect of fishing on stock depletion). Past statistical power analyses show that abundance estimation techniques usually have high Beta and that only large effects are detectable. In order to address this problem, relationships among Beta, power, detectable effect size, sample size and sampling variability are reviewed; how statistical power analysis can help interpret past results and improve designs of future experiments, impact assessments, and management regulations is shown; and recommendations are made for researchers and decision makers, including routine application of power analysis, more cautious management and reversal of the burden of proof to put it on industry not management agencies. (Author's abstract)
W90-06109

ASSESSING THE POTENTIAL EXTENT OF DAMAGE TO INLAND LAKES IN EASTERN CANADA DUE TO ACIDIC DEPOSITION. I. DEVELOPMENT AND EVALUATION OF A SIMPLE 'SITE' MODEL.
Environmental and Social Systems Analysts Ltd., Vancouver (British Columbia).
For primary bibliographic entry see Field 5C.
W90-06113

ASSESSING THE POTENTIAL EXTENT OF DAMAGE TO INLAND LAKES IN EASTERN CANADA DUE TO ACIDIC DEPOSITION: II. APPLICATION OF THE REGIONAL MODEL.
Environmental and Social Systems Analysts Ltd., Toronto (Ontario).
For primary bibliographic entry see Field 5C.
W90-06114

NIGHTTIME POND RESPIRATION RATE: OXYGEN OR TEMPERATURE DEPENDENT.
Hawaii Univ., Honolulu. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W90-06122

BIOMOVS: AN INTERNATIONAL MODEL VALIDATION STUDY.
Statens Straalskyddsinstitut, Stockholm (Sweden).
For primary bibliographic entry see Field 5B.
W90-06174

SLUDGE INCINERATION MODELING (SIM) SYSTEM USER'S GUIDE.
General Sciences Corp., Laurel, MD.
For primary bibliographic entry see Field 5D.
W90-06194

WATER ENCYCLOPEDIA.
For primary bibliographic entry see Field 2A.
W90-06196

GROUNDWATER CHEMICALS DESK REFERENCE.
For primary bibliographic entry see Field 5A.
W90-06205

3CPO--CLOUD CHEMISTRY AND CLOUD PHYSICS ORGANIZATION. JUNE 1988: DATA INDEX.
Brookhaven National Lab., Upton, NY. Atmospheric Sciences Div.
For primary bibliographic entry see Field 2B.
W90-06212

CONVERSION AND COMPARISON OF THE MATHEMATICAL, THREE-DIMENSIONAL, FINITE-DIMENSIONAL, GROUND-WATER FLOW MODEL TO THE MODULAR, THREE-DIMENSIONAL, FINITE-DIFFERENCE, GROUND-WATER FLOW MODEL FOR THE TESUQUE AQUIFER SYSTEM IN NORTHERN NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06222

WATER-RELATED SCIENTIFIC ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN NEVADA, FISCAL YEARS 1985-89.
Geological Survey, Carson City, NV. Water Resources Div.
K. C. Kilroy.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-264, 1989. 99p, 4 fig, 3 tab, 161 ref.

Descriptors: *Data collections, *Hydrologic data, *Hydrology, *Interagency cooperation, *Nevada, *Water resources data, Geochemistry, Geographic information systems, Geophysics, Groundwater, Publications, Remote sensing, Surface water, Water quality, Water resources.

The U.S. Geological Survey has been collecting water resources data in Nevada since 1890. Most of the projects in the current Nevada District program can be classified as either basic-data acquisition (about 25%) or hydrologic interpretation (about 75%). About 52% of the activities are supported by cooperative agreements with State and local agencies. Technical projects supported by other Federal agencies make up about 23% of the program, and the remaining 25% consists of data collection, research, and interpretive projects supported directly by the U.S. Geological Survey. Water conditions in Nevada during the 4 years covered by this report were by no means average, with 1 very wet year (1986) and 2 very dry years (1987-88). The major water resources issues include: water allocation in the Truckee-Carson River basin; irrigation return flow contamination of the Stillwater Wildlife Management Area; effects of weapons testing at the Nevada Test Site; assessment of potential long-term impacts of the proposed Yucca Mountain Nuclear Waste Repository; and drought. Future water-resources issues in Nevada are likely to center on water supply for and the environmental effects of, the rapidly growing population centers at Las Vegas, Reno, and Elko; impacts of operations at the Nevada Test Site; management of interstate rivers such as the Truckee and Colorado Rivers; hydrologic and environmental impacts at heavily mined areas; and water quality management in the Lake Tahoe Basin. (Thacker-USGS-WRD)
W90-06226

SIMULATION OF THE REGIONAL GEOHYDROLOGY OF THE TESUQUE AQUIFER SYSTEM.
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06229

HYDROGRAPHS FROM SELECTED OBSERVATION WELLS AND ANNUAL PUMPAGE FROM MUNICIPAL SUPPLY WELLS, 1950-86, SANTA FE, NEW MEXICO.
Geological Survey, Albuquerque, NM. Water Resources Div.
R. G. Roybal.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-339, Jun 1988. 1 (map) sheet.

Descriptors: *Municipal water, *New Mexico, *Pumpage, *Santa Fe, *Water use, Hydrographs, Maps.

Annual pumpage of the municipal supply wells in Santa Fe, New Mexico has fluctuated from zero to over 4,000 acre-ft in a seemingly random manner during the period from 1950 to 1986. Water levels of seven selected observation wells have shown an overall gradual decrease in altitude ranging from about 5 to 10+ ft during the period of record. Three observation wells have shown some fluctuations but water levels have remained essentially unchanged overall, and two of the selected observation wells have shown a slight overall increase in water level altitude of 5 to 20 ft during the period of record. (USGS)
W90-06231

COMPUTERIZED DATA-BASE SYSTEM FOR LAND-USE AND LAND-COVER DATA COLLECTED AT GROUND-WATER SAMPLING SITES IN THE PILOT NATIONAL WATER QUALITY ASSESSMENT PROGRAM.
Geological Survey, Oklahoma City, OK. Water Resources Div.
J. C. Scott.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4172, November 1989. 139p, 23 fig, 8 tab, 13 ref.

Descriptors: *Computer programs, *Data storage and retrieval, *Groundwater, *Land use, *Water resources data, Data processing, Databases.

Data-base software has been developed for the management of land-use and land-cover data collected by the U.S. Geological Survey as part of a pilot program to test and refine concepts for a National Water-Quality Assessment Program. This report describes the purpose, use, and design of the land-use and land-cover data-base software. The software provides capabilities for interactive storage and retrieval of land-use and land-cover data collected at groundwater sampling sites. Users of the software can add, update, and delete land-use and land-cover data. The software also provides capabilities to group, print, and summarize the data. The land-use and land-cover data base software supports multiple data base systems so that data can be assessed by persons in different offices. Data-base systems are organized in a tiered structure. Each data-base system contains all the data stored in the data-base systems located in lower tiers of the structure. Data can be readily transmitted from lower tiers to higher tiers of the structure. Therefore, the data-base system at the highest tier of the structure contains land-use and land cover data for the entire pilot program. (USGS)
W90-06234

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSOURI, FISCAL YEAR 1989.
Geological Survey, Rolla, MO. Water Resources Div.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-621, 1990. 54p, 8 fig, 1 tab, 133 ref. Compiled by K. L. Jenkins.

Descriptors: *Data collections, *Hydrologic data, *Missouri, *Water resources data, Groundwater data, Surface water data, Water quality.

Water resources activities of the U.S. Geological Survey in Missouri consist of collecting hydrologic data and making interpretive studies. Hydrologic studies in Missouri are made through three basic types of projects: hydrologic data collection programs; local or areal hydrologic investigations; and statewide or regional studies. These projects are funded through cooperative joint-funding agreements with State and local agencies, transfer of funds from other Federal agencies, and direct Federal funds. The data and the results of the investigations are published or released by either the U.S. Geological Survey or by cooperating agencies. The report describes the hydrologic data collection programs and local or areal hydrologic investigations in Missouri for fiscal year 1989 and provides a list of selected water resources references for Missouri. (USGS)
W90-06244

COMPUTER PROGRAM FOR CONVERTING RECTANGULAR COORDINATES TO LATITUDE-LONGITUDE COORDINATES.
Geological Survey, Tallahassee, FL. Water Resources Div.
A. T. Rutledge.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4070, 1989. 20p, 5 fig, 1 ref. USGS Project FL-410.

Descriptors: *Computer programs, *Coordinate transformation, *Mapping, Computer models, Coordinates, Geography, Latitude, Longitude, Map coordinates, Maps, Radial coordinates, Rectangular coordinates.

A computer program was developed for converting the coordinates of any rectangular grid on a map to coordinates on a grid that is parallel to lines of equal latitude and longitude. Using this program in conjunction with groundwater flow models, the user can extract data and results from models with varying grid orientations and place these data into grid structure that is oriented parallel to lines of equal latitude and longitude. All cells in the rectangular grid must have equal dimensions, and all cells in the latitude-longitude grid measure one minute by one minute. This program is applicable if the map used shows lines of equal latitude as arcs and lines of equal longitude as straight lines and assumes that the Earth's surface can be approximated as a sphere. The program user enters the row number, column number, and latitude and longitude of the midpoint of the cell for three test cells on the rectangular grid. The latitude and longitude of boundaries of the rectangular grid also are entered. By solving sets of simultaneous linear equations, the program calculates coefficients that are used for making the conversion. As an option in the program, the user may build a groundwater model file based on a grid that is parallel to lines of equal latitude and longitude. The program reads a data file based on the rectangular coordinates and automatically forms the new data file. (USGS)
W90-06246

WATER RESOURCES DATA FOR OREGON WATER, YEAR 1988, VOLUME 2. WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. E. Hubbard, T. A. Herrett, R. L. Kraus, and R. L. Moffatt.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-0161803/AS. Price codes: A15 in paper copy, A01 in microfiche. Water-Data Report OR-88-2 (USGS/WRD/HD-90/237), 1989. 320p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Gaging stations, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water Resources Data for the 1988 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 250 gaging stations; stage only records for 7 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 44 stations, and water quality for 3 precipitation stations. Also included are 5 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-05260) (USGS)
W90-06250

WATER RESOURCES DATA COLLECTED DURING WATER YEAR 1988 AT SELECTED JAMES RIVER BASIN SITES IN NORTH DAKOTA AND SOUTH DAKOTA.
Geological Survey, Huron, SD. Water Resources Div.
S. K. Sando, K. G. Guttomson, and T. A. Gleich.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-101, 1990. 230p, 3 fig, 41 tab, 9 ref.

Descriptors: *Garrison Diversion Unit, *James River Basin, *North Dakota, *Stream discharge, *Streamflow data, *Surface water data, *Water quality, *Water resources data, Reservoir elevation, Stream gage height.

Operation of the proposed Garrison Diversion Unit will supply water from the Missouri River in North Dakota to the upstream part of the James River basin. The U.S. Bureau of Reclamation initiated a monitoring program in 1984 to aid in determining whether the potential impacts resulting from Garrison Diversion Unit operation will be compatible with the operational objectives of the three national wildlife refuges located on the James River in North Dakota and South Dakota. This report presents water resources data collected by the U.S. Geological Survey during water year 1988 in the James River basin as part of the Garrison Diversion Unit monitoring program. Water discharge records for 12 stations, reservoir elevation and contents records for one station, stream gage-height records for three stations, and water quality records for 23 stations are presented. (USGS)
W90-06256

GEOHYDROLOGY OF THE REGIONAL AQUIFER SYSTEM, WESTERN SNAKE RIVER PLAIN, SOUTHWESTERN IDAHO.
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-06257

WATER RESOURCES DATA FOR VIRGINIA WATER YEAR 1985.
Geological Survey, Richmond, VA. Water Resources Div.
B. J. Prugh, F. J. Easton, and D. D. Lynch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-111852/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report VA-85-1 (WRD/HD-86/255), 1986. 398p. Prepared in cooperation with the State of Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Virginia, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Virginia consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 190 gaging stations, stage only at 1 gaging station, stage and contents at 10 lakes and reservoirs, water quality at 41 gaging stations and 1 well, and water levels at 58 observation wells. Also included are data for 78 crest-stage partial-record stations. Additional water data were collected at various sites

not involved in the systematic data-collection program, such as, discharge-measurement data collected at 53 low-flow partial-record stations, and miscellaneous hydrologic data collected at 97 measuring sites and 12 water-quality sampling sites. The data in this report represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Virginia. (USGS)
W90-06261

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1982. VOLUME 1. WESTERN WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB85-236826. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report WA-82-1 (WRD/HD-85/220), 1985. 310p. Prepared in cooperation with the State of Washington and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Washington, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

The Water resources data for the 1982 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report, in two volumes, contains discharge records for 253 gaging stations; stage only records for 8 gaging stations; stage and contents for 37 lakes and reservoirs; water quality for 81 gaging stations; and water levels for 57 observation wells. Also included are data for 33 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating local, state and federal agencies in Washington. (See also W90-06263) (USGS)
W90-06262

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1982. VOLUME 2. EASTERN WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-236834. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report WA-82-2 (WRD/HD-85/221), 1985. 211p. Prepared in cooperation with the State of Washington and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Washington, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1982 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report, in two volumes, contains discharge records for 253 gaging stations; stage only records for 8 gaging stations; stage and contents for 37 lakes and reservoirs; water quality for 81 gaging stations; and water levels for 57 observation wells. Also included are data for 33 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating local, state and federal agencies in Washington. (See also W90-06262) (USGS)
W90-06263

WATER RESOURCES DATA FOR WASHINGTON WATER YEAR 1983.
Geological Survey, Tacoma, WA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-162542. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report (WRD/HD-86/204), 1985. 433p. Prepared in cooperation with the State of Washington and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Washington, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1983 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report contains discharge records for 200 gaging stations; stage only records for 22 gaging stations; stage and contents for 22 lakes and reservoirs; water quality for 43 gaging stations; and water levels for 124 observation wells. Also included are data for 79 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating local, state and federal agencies in Washington. (See also W90-06262) (USGS)
W90-06264

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1984.
Geological Survey, Charleston, WV. Water Resources Div.
W. N. Embree, W. A. Friel, and F. M. Taylor.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-162641. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report WV-84-1 (WRD/HD-85/274), 1985. 323p. Prepared in cooperation with the State of West Virginia and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *West Virginia, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

The Water resources data for the 1984 water year for West Virginia consist of records of stage, discharge, and water quality of streams and springs, and water levels in wells. This report contains discharge records for 76 gaging stations; stage only records for 13 gaging stations; content for 2 reservoirs; change in contents for 1 reservoir; water quality for 24 gaging stations; and water levels for 31 observation wells. Also included are 2 crest-stage partial-record stations, and 1 low-flow partial record station. Additional water data were collected at various sites, not part of the systemic data collections program, and are published as miscellaneous measurements and analysis. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in West Virginia. Field data for two projects are also included in this report: the first group includes data collected during the period 1980-1982 for the water resources study of the Gauley River basin. Included are physical data for 250 wells, quality analysis of water from 125 wells, discharge and chemical data for 53 sites sampled occasionally, and discharge and chemical data for 17 index sites sampled monthly. The geology and hydrology of the basin will be described in greater detail in a future report. The second group includes discharge and field determinations collected at 293 sites throughout the State during September and October 1983. This information will be included with other data for a project studying low flow characteristics in West Virginia. (USGS)
W90-06265

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1984.
Geological Survey, Madison, WI. Water Resources Div.
B. K. Holmstrom, P. A. Kammerer, and R. M. Erickson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-197084. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report WI-84-1 (WRD/HD-86/213), 1985. 373p. Prepared in cooperation with the State of Wisconsin and other agencies.

Descriptors: *Acid rain, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wisconsin, Chemical analysis, Flow rates, Gaging stations, Lakes, Microbiological analysis, Sediments, Water level.

Water resources data for the 1984 water year for Wisconsin include records of streamflow at gaging stations, partial-record stations, and miscellaneous sites; records of chemical, biological, and physical characteristics of surface and groundwater. Records of chemical analysis of precipitation, surface and groundwater associated with acid deposition are. included. In addition water levels in observation wells are reported. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Wisconsin. (USGS)
W90-06266

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1984.
Geological Survey, Cheyenne, WY. Water Resources Div.
S. A. Druse, and S. J. Rucker.
Available from the National Technical Information Service, Springfield, VA 22161, PB86-106127. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report 84 (WRD/HD-85/252), 1985. 470p. Prepared in cooperation with the State of Wyoming and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wyoming, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Wyoming consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 186 gaging stations; stage and contents for 14 lakes and reservoirs; water quality for 72 gaging stations, and 66 ungaged stations; and water levels for 4 observation wells. Also included are 32 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Wyoming. (USGS)
W90-06267

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1985.
Geological Survey of Alabama, University. Div. of Water Resources.
H. C. Rollins, F. C. Sedberry, T. R. Duvall, and F. D. Byrd.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172284. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report AL-85 (WRD/HD-87/203), 1986. 286p. Prepared in cooperation with the state of Alabama and other agencies.

Descriptors: *Alabama, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites,

Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Alabama consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels in wells. This report includes records on both surface and ground water in the State. Specifically, it contains: (1) Discharge records for 86 streamflow-gaging stations, for 62 partial-record or miscellaneous streamflow stations, and for 4 crest-stage or partial-record streamflow stations; (2) stage and content records for 13 lakes and reservoirs and stage at 27 stations; (3) water-quality records for 22 streamflow-gaging stations, for 66 ungaged streamsites, and for 7 wells; and (4) water-level records for 62 observation wells. Discharge records for a few pertinent stations in bordering States are also included in this report. (USGS)
W90-06268

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1986.
Geological Survey of Alabama, University. Div. of Water Resources.
H. C. Rollins, F. C. Sedberry, J. L. Pearman, and T. R. Duvall.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-136551/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report AL-86-1 (WRD/HD-87/272), 1987. 307p. Prepared in cooperation with the state of Alabama and other agencies.

Descriptors: *Alabama, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Alabama consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels in wells. This report includes records on both surface and ground water in the State. Specifically, it contains: (1) Discharge records for 84 streamflow-gaging stations, for 134 partial-record or miscellaneous streamflow stations, and for 2 crest-stage or partial-record streamflow stations; (2) stage and content records for 13 lakes and reservoirs and stage at 27 stations; (3) water-quality records for 23 streamflow-gaging stations, for 27 ungaged streamsites, for 36 wells, and 3 precipitation stations; (4) water temperature at 6 surface-water stations; and (5) water-level records for 17 observation wells. Discharge records for a few pertinent stations in bordering States are also included in this report. (See also W90-06268) (USGS)
W90-06269

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1987.
Geological Survey of Alabama, University. Div. of Water Resources.
H. C. Rollins, F. C. Sedberry, J. L. Pearman, and T. R. Duvall.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-120349/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report AL-87-1 (WRD/HD-88/270), 1988. 337p. Prepared in cooperation with the state of Alabama and other agencies.

Descriptors: *Alabama, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Alabama consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels in wells. This report includes records on both surface and ground water in the State. Specifically, it contains: (1) Discharge records for 84 streamflow-gaging stations, for 58 partial-record or miscellaneous streamflow stations, and for 2 crest-stage or partial-record streamflow stations; (2) stage and content records for 13 lakes and reservoirs and stage at 27 stations; (3) water-quality records for 22 streamflow-gaging stations, for 66 ungaged streamsites, for 12 wells, and 3 precipitation stations; (4) water temperature at 9 surface-water stations; and (5) water-level records for 20 observation wells. Discharge records for a few pertinent stations in bordering States are also included in this report. (See also W90-06269) (USGS)
W90-06270

WATER RESOURCES DATA FOR ALABAMA, WATER YEAR 1988.
Geological Survey of Alabama, University. Div. of Water Resources.
H. C. Rollins, J. L. Pearman, F. C. Sedberry, and P. W. Cole.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194534/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report AL-88-1 (WRD/HD-89/230), 1989. 324p. Prepared in cooperation with the State of Alabama and other agencies.

Descriptors: *Alabama, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Alabama consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels in wells. This report includes records on both surface and ground water in the State. Specifically, it contains: (1) Discharge records for 92 streamflow-gaging stations, for 132 partial-record or miscellaneous streamflow stations; (2) stage and content records for 13 lakes and reservoirs and stage at 27 stations; (3) water-quality records for 24 streamflow-gaging stations, for 2 lake stations, for 56 ungaged streamsites, for 6 wells, and 3 precipitation stations; (4) water temperature at 12 surface-water stations; and (5) water-level records for 20 observation wells. Discharge records for a few pertinent stations in bordering States are also included in this report. (See also W90-06270) (USGS)
W90-06271

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1985.
Geological Survey, Anchorage, AK. Water Resources Div.
B. B. Bigelow, R. D. Lamke, P. J. Still, J. L. Van Maanen, and J. E. Vaill.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-182910/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report AK-85-1 (WRD/HD-86/252), 1986. 328p. Prepared in cooperation with the State of Alaska and with other agencies.

Descriptors: *Alaska, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality in wells. This report contains discharge records for 108 gaging stations; water quality for 40 stations; and water levels for 31 observation wells. Also included are 66 crest-stage, 15 low-flow, and 19 water-quality partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements of discharge, lake stage, or water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska. (USGS)
W90-06272

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1986.
Geological Survey, Anchorage, AK. Water Resources Div.
J. L. VanMaanen, R. D. Lamke, P. J. Still, J. E. Vaill, and B. B. Bigelow.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-197421. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report AK-86-1 (WRD/HD-88/214), 1988. 330p. Prepared in cooperation with the State of Alaska and with other agencies.

Descriptors: *Alaska, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 103 gaging stations; water quality at 42 gaging stations; and water levels for 30 observation wells. Also included are data for 18 low-flow, 68 crest-stage, and 18 water-quality partial-record stations and 40 lakes. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska. (See also W90-06272) (USGS)
W90-06273

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1987.
Geological Survey, Anchorage, AK. Water Resources Div.
J. E. Vaill, P. J. Still, R. D. Lamke, B. B. Bigelow, and J. L. VanMaanen.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-139588/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report AK-87-1 (WRD/HD-89/209), 1988. 284p. Prepared in cooperation with the State of Alaska and with other agencies.

Descriptors: *Alaska, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 83 gaging stations; water quality at 27 gaging stations; and water levels for 29 observation wells. Also included are data for 16 low-flow, 86 crest-stage, and 14 water-quality partial-record stations and 20 lakes. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska. (See also W90-06273) (USGS)
W90-06274

WATER RESOURCES DATA FOR ALASKA, WATER YEAR 1988.
Geological Survey, Anchorage, AK. Water Resources Div.
B. B. Bigelow, R. D. Lamke, P. J. Still, J. L. VanMaanen, and R. L. Burrows.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-212294/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report AK-88-1 (WRD/HD-89/231), 1989. 196p. Prepared in cooperation with the State of Alaska and with other agencies.

Descriptors: *Alaska, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Alaska consist of records of stage, discharge, and water quality of streams; stage of lakes; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 85 gaging stations; water quality at 24 gaging stations, and water levels for 26 observation wells. Also included are data for 66 crest-stage partial-record stations and 13 lakes. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Alaska. (See also W90-06274) (USGS)
W90-06275

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1984.
Geological Survey, Tucson, AZ.
N. D. White, and W. B. Garrett.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-227567. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report AZ-84-1 (WRD/HD-87/228), 1987. 381p. Prepared in cooperation with the State of Arizona and with other agencies.

Descriptors: *Arizona, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels of observation wells; and quality of groundwater. This report contains discharge records for 184 gaging stations, annual peaks for 23 crest-stage partial-record stations, and discharge measurements at 9 miscellaneous sites; peak discharges for the flood of October 1-4, 1983, at 24 discontinued gaging stations and miscellaneous sites; contents only records for 8 lakes and reservoirs; stage and contents for 1 lake; elevation only for 1 streamflow station; 16 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; water-quality records for 43 continuous-record stations and 3 miscellaneous sites; water levels for 95 observation wells; and water-quality data for water from 116 wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Arizona. (USGS)
W90-06276

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1985.
Geological Survey, Tucson, AZ.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-197546. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report AZ-85-1 (WRD/HD-88/215), 1988. 343p. Prepared in cooperation with the State of Arizona and with other agencies.

Descriptors: *Arizona, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels of observation wells; and quality of ground water. This report contains discharge records for 186 gaging stations, annual peaks for 24 crest-stage partial-record stations, and discharge measurements at 7 miscellaneous sites; contents only records for 8 lakes and reservoirs; stage and contents for 1 lake; elevation only for 1 streamflow station; 18 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; water-quality records for 34 continuous-record stations and 5 miscellaneous sites; water levels for 95 observation wells; and water-quality data for water from 230 wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Arizona. (See also W90-06276) (USGS)
W90-06277

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1986.
Geological Survey, Tucson, AZ.
R. P. Wilson, and W. B. Garrett.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-130793/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report AZ-86-1 (WRD/HD-88/262), 1988. 341p. Prepared in cooperation with the State of Arizona and with other agencies.

Descriptors: *Arizona, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; water levels of observation wells; and quality of groundwater. This report contains discharge records for 171 gaging stations, annual peaks for 21 crest-stage partial-record stations, and discharge measurements at 11 miscellaneous sites; contents only records for 9 lakes and reservoirs; stage and contents for 1 lake; elevation only for 1 streamflow station; 22 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; water-quality records for 33 continuous-record stations and 8 miscellaneous sites; water levels for 88 observation wells; and water-quality data for water from 345 wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Arizona. (See also W90-06277) (USGS)
W90-06278

WATER RESOURCES DATA FOR ARIZONA, WATER YEAR 1987.
Geological Survey, Tucson, AZ.
R. P. Wilson, and W. B. Garrett.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194963/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report AZ-87-1 (WRD/HD-89/218), 1989. 385p. Prepared in cooperation with the State of Arizona and with other agencies.

Descriptors: *Arizona, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Arizona consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels of observation wells; and quality of groundwater. This report contains discharge records for 168 gaging stations, annual peaks for 22 crest-stage partial-record stations, and discharge measurements at 8 miscellaneous sites; contents only records for 9 lakes and reservoirs; stage and contents for 1 lake; elevation only for 1 streamflow station; 20 supplementary records, included with gaging-station records, consisting of monthend or monthly stage, contents, and evaporation of lakes and reservoirs, diversions, and return flows; water-quality records for 41 continuous-record stations and 6 miscellaneous sites; water levels for 1,007 observation wells; and water-quality data for water from 261 wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Arizona. (See also W90-06278) (USGS)
W90-06279

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1986.
Geological Survey, Little Rock, AR. Water Resources Div.
T. E. Lamb, J. E. Porter, B. F. Lambert, and J. Edds.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-231031/AS. Price codes: A23 in paper copy, A01 in microfiche. USGS Water-Data Report AR-86-1 (WRD/HD-87/240), 1987. 533p. Prepared in cooperation with the State of Arkansas and with other agencies.

Descriptors: *Arkansas, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Arkansas consist of records of discharge, and water quality of streams; water quality of lakes; water levels and water quality of observation wells. This report contains discharge records for 48 regular surface-water stations; water-quality data for 154 regular water-quality stations, 73 partial-record water-quality stations, 5 observation wells, and 1 precipitation station; water-level measurements for 96 observation wells. Also included are data for 85 crest-stage partial-record surface-water stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Arkansas. (USGS)
W90-06280

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1987.
Geological Survey, Little Rock, AR. Water Resources Div.
T. E. Lamb, J. E. Porter, B. F. Lambert, and M. Plafcan.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-246897/AS. Price codes: A25 in paper copy, A01 in microfiche. USGS Water-Data Report AR-87-1 (WRD/HD-88/259), 1988. 575p. Prepared in cooperation with the State of Arkansas and with other agencies.

Descriptors: *Arkansas, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Arkansas consist of records of gage height, discharge, and water quality of streams; water quality of lakes; water levels, and water quality of observation wells. This report contains discharge records for 47 gaging stations; water-quality data for 160 regular water-quality stations, 63 partial-record water-quality stations, 5 observation wells, and 1 precipitation station; water-level measurements for 97 observation wells. Also included are data for 58 crest-stage partial-record surface-water stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the

U.S. Geological Survey and cooperating State and Federal agencies in Arkansas. (See also W90-06280) (USGS)
W90-06281

WATER RESOURCES DATA FOR ARKANSAS, WATER YEAR 1988.
Geological Survey, Little Rock, AR. Water Resources Div.
M. A. Moore, J. E. Porter, P. W. Westerfield, and K. Young.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-214191/AS. Price codes: A99 in paper copy, A01 in microfiche. USGS Water-Data Report AR-88-1 (WRD/HD-89/225), 1989. 622p. Prepared in cooperation with the State of Arkansas and with other agencies.

Descriptors: *Arkansas, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Arkansas consist of records of gage height, discharge, and water quality of streams; water quality of lakes; water levels, and water quality of observation wells. This report contains discharge records for 51 gaging stations; water-quality data for 159 regular water-quality stations, 63 partial-record water-quality stations, 6 observation wells, and 1 precipitation station; water-level measurements for 97 observation wells. Also included are data for 57 crest-stage partial-record surface-water stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Arkansas. (See also W90-06281) (USGS)
W90-06282

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1984. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
R. P. Fogelman, J. R. Mullen, W. F. Shelton, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-182036/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CA-84-4 (WRD/HD-86/228), 1986. 277p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 152 gaging stations; stage and contents for 25 lakes and reservoirs; water precipitation data for 2 stations; water quality for 9 stations; water levels for 12 and water quality for 46 observation wells. Also included is one low-flow partial-record station and 19 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (USGS)
W90-06283

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
J. C. Bowers, C. E. McConaughy, K. G. Polinoski, and G. B. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-222980/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report CA-85-1 (WRD/HD-87/229), 1987. 325p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1985 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 1 contains discharge records for 150 gaging stations; stage and contents for 17 lakes and reservoirs; water quality for 23 streams. Also included are 10 crest-stage partial-record stations, three miscellaneous measurement sites, and one water-quality partial-record station. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06285 thru W90-06288) (USGS)
W90-06284

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
S. Anderson, K. L. Markham, L. F. Trujillo, W. F. Shelton, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-121637/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CA-85-2 (WRD/HD-87/255), 1987. 341p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sediments, Water analysis, Water temperature.

Water resources data for the 1985 water year for California consist of records of stage, discharge, and water quality of streams; and stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 2 contains discharge records for 133 gaging stations; stage and contents for 9 lakes and reservoirs; and water quality for 34 stations. Also included are 3 low-flow partial-record stations and 18 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06284 and W90-06286 thru W90-06288) (USGS)
W90-06285

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
T. C. Hunter, J. R. Mullen, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-131214. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report CA-85-3 (WRD/HD-87/265), 1987. 381p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1985 water year for California consist of records of stage, discharge, and water quality of streams and stage and contents in lakes and reservoirs. Volume 3 contains discharge records for 149 gaging stations; stage and contents for 41 lakes and reservoirs; gage height records for 2 lakes; and water quality for 34 streams. Also included are 4 crest-stage partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06284 thru W90-06285 and W90-06287 thru W90-06288) (USGS)
W90-06286

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 4. NORTHERN CALIFORNIA VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
J. R. Mullen, W. F. Shelton, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-170188. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report CA-85-4 (WRD/HD-87/270), 1987. 289p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sediments, Water temperature.

Water resources data for the 1985 water year for California consist of records of stage, discharge, and water quality of streams; and stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 155 gaging stations; stage and contents for 29 lakes and reservoirs; water precipitation data for 2 stations; and water quality for 16 stations. Also included are 7 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06284 thru W90-06286 and W90-06288)) (USGS)
W90-06287

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1985. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
D. E. Maltby, K. T. Downing, G. L. Keeter, and C. E. Lamb.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-116561/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CA-85-5 (WRD/HD-87/223), 1987. 359p. Prepared in cooperation with other Federal, State, and local agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, Chemical analysis, Sampling sites, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 5 contains water levels for 1052 observation wells, and water-quality data

for 924 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06284 thru W90-06287) (USGS)
W90-06288

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
J. C. Bowers, C. E. McConaughy, K. G. Polinoski, and G. B. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-230867. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report CA-86-1 (WRD/HD-88/221), 1988. 301p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1986 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 1 contains discharge records for 144 gaging stations; stage and contents for 15 lakes and reservoirs; water quality for 21 streams. Also included are crest-stage partial-record stations, 3 miscellaneous measurement sites, and 5 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06284 and W90-06290 thru W90-06293) (USGS)
W90-06289

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
S. Anderson, K. L. Markham, W. F. Shelton, L. F. Trujillo, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-230891. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report CA-86-2 (WRD/HD-88/222), 1988. 371p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1986 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 2 contains discharge records for 132 gaging stations; stage and contents for 11 lakes and reservoirs; and water quality for 32 stations. Also included are 4 partial-record stations and 24 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06289 and W90-06291 thru W90-06293) (USGS)
W90-06290

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
T. C. Hunter, J. R. Mullen, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-241591/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CA-86-3 (WRD/HD-88/223), 1988. 353p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1986 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 3 contains discharge records for 159 gaging stations; stage and contents for 37 lakes and reservoirs; gage height records for 2 lakes; and water quality for 16 streams. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06289 thru W90-06290 and W90-06292 thru W90-06293) (USGS)
W90-06291

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
J. R. Mullen, W. F. Shelton, R. G. Simpson, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-230941. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CA-86-4 (WRD/HD-88/224), 1988. 286p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sediments, Water analysis, Water temperature.

Water resources data for the 1986 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 156 gaging stations; stage and contents for 37 lakes and reservoirs; water precipitation data for 2 stations; and water quality for 8 stations. Also included is one water-quality partial-record station. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06289 thru W90-06291 and W90-06293) (USGS)
W90-06292

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1986. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
C. E. Lamb, G. L. Keeter, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-232335/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report CA-86-5 (WRD/HD-88/225), 1988. 317p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, Chemical analysis, Sampling sites, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 5 contains water levels for 765 observation wells and water-quality data for 174 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06289 thru W90-06292) (USGS)
W90-06293

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
J. C. Bowers, C. E. McConaughy, K. G. Polinoski, and G. B. Smith.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-166789/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report CA-87-1 (WRD/HD-89/206), 1988. 303p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1987 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 1 contains discharge records for 134 gaging stations; stage and contents for 16 lakes and reservoirs; and water quality for 16 streams. Also included are 10 crest-stage partial-record stations, 3 miscellaneous measurement sites, and 10 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06289 and W90-06295 thru W90-06298) (USGS)
W90-06294

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
S. Anderson, K. L. Markham, W. F. Shelton, and L. F. Trujillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-126296/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report CA-87-2 (WRD/HD-88/283), 1988. 315p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1987 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 2 contains discharge records for 123 gaging stations; stage and contents for 7 lakes and reservoirs; and water quality for 29 stations. Also included are 1 partial-record station and 24 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in

California. (See W90-06294 and W90-06296 thru W90-06298) (USGS)
W90-06295

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
T. C. Hunter, J. R. Mullen, and R. G. Simpson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-126452/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report CA-87-3 (WRD/HD-88/284), 1988. 392p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1987 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 3 contains discharge records for 177 gaging stations; stage and contents for 46 lakes and reservoirs; and water quality for 29 stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06294 thru W90-06295 and W90-06297 thru W90-06298) (USGS)
W90-06296

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
J. R. Mullen, W. F. Shelton, and R. G. Simpson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-132286/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CA-87-4 (WRD/HD-88/285), 1988. 276p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1987 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 154 gaging stations; stage and contents for 33 lakes and reservoirs; water precipitation data for 2 stations; and water quality for 5 stations. Also included is one low-flow partial-record station. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06294 thru W90-06296 and W90-06298) (USGS)
W90-06297

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1987. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
C. E. Lamb, R. P. Fogelman, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-190458/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CA-87-5 (WRD/HD-89/221), 1989. 291p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, Chemical analysis, Sampling sites, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 5 contains water levels for 786 observation wells and water-quality data for 168 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06294 thru W90-06297) (USGS)
W90-06298

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 1. SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
K. G. Polinoski, E. B. Hoffman, G. B. Smith, and J. C. Bowers.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203467. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CA-88-1 (WRD/HD-89/250), 1989. 271p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water temperature.

Water resources data for the 1988 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 1 contains discharge records for 134 gaging stations; stage and contents for 17 lakes and reservoirs; and water quality for 24 streams. Also included are 10 crest-stage partial-record stations, 5 miscellaneous measurement sites, and 16 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06294 and W90-06300 thru W90-06303) (USGS)
W90-06299

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Sacramento, CA. Water Resources Div.
K. L. Markham, J. R. Palmer, W. F. Shelton, and L. F. Trujillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-207625/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report CA-88-2 (WRD/HD-89/251), 1989. 327p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water temperature.

Water resources data for the 1988 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 2 contains discharge records for 123 gaging stations; stage and contents for 7 lakes and reservoirs; and water quality for 38 stations. Also included are 1 low-flow partial-record station and 22 water-quality partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06299 and W90-06301 thru W90-06303) (USGS)
W90-06300

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Sacramento, CA. Water Resources Div.
J. R. Mullen, S. W. Anderson, and T. C. Hunter.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-237325/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report CA-88-3 (WRD/HD-89/252), 1989. 419p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1988 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 3 contains discharge records for 178 gaging stations; stage and water contents for 47 lakes and reservoirs; water quality for 32 stations; and 4 crest-stage partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06299 thru W90-06300 and W90-06302 thru W90-06303) (USGS)
W90-06301

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Sacramento, CA. Water Resources Div.
W. F. Shelton, S. W. Anderson, and R. J. Mullen.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203475/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report CA-88-4 (WRD/HD-89/253), 1989. 289p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1988 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 4 contains discharge records for 160 gaging stations; stage and contents for 35 lakes and reservoirs; water precipitation data for 2 stations; and water quality for 9 stations. Also included is one low-flow partial-record station. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06299 thru W90-06301 and W90-06303) (USGS)
W90-06302

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1988. VOLUME 5. GROUND-WATER DATA FOR CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.
C. E. Lamb, R. P. Fogelman, and D. A. Grillo.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203483. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CA-88-5 (WRD/HD-89/254), 1989. 357p. Prepared in cooperation with the California Department of Water Resources and with other agencies.

Descriptors: *California, *Data collections, *Groundwater, *Hydrologic data, Chemical analysis, Sampling sites, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for California consist of records of stage, discharge, and water quality of streams; stage and contents in lakes and reservoirs; and water levels and water quality in wells. Volume 5 contains water levels for 980 observation wells and water-quality data for 239 observation monitoring wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (See W90-06299 and W90-06302) (USGS)
W90-06303

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1986. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, J. T. Steinheimer, J. L. Ebling, and R. D. Steger.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-121371/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CO-86-1 (WRD/HD-87/263), 1987. 345p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for Colorado for the 1986 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water discharge records for 374 gaging stations, stage and contents of 24 lakes and reservoirs, 5 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and 1 miscellaneous site; water quality for 118 gaging stations and 256 miscellaneous sites; and water levels for 44 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-06305) (USGS)
W90-06304

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1986. VOLUME 2. COLORADO RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, J. T. Steinheimer, R. G. Kretschman, E. A. Wilson, and J. D. Bennett.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-121389/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report CO-86-2 (WRD/HD-87/264), 1987. 434p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for Colorado for the 1986 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report (Volumes 1 and 2) contains discharge records for 374 gaging stations, stage and contents of 24 lakes and reservoirs, 5 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and 1 miscellaneous site; water quality for 118 gaging stations and 256 miscellaneous sites; and water levels for 44 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-06304) (USGS)
W90-06305

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1987. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, J. L. Ebling, and R. D. Steger.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-243043/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report CO-87-1 (WRD/HD-88/249), 1988. 409p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for Colorado for the 1987 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water discharge records for 319 gaging stations, stage and contents of 24 lakes and reservoirs, 5 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and 1 miscellaneous site; water quality for 115 gaging stations, 177 miscellaneous sites, and for 14 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See W90-06304 and W90-06307) (USGS)
W90-06306

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1987. VOLUME 2. COLORADO RIVER BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, R. G. Kretschman, E. A. Wilson, and J. D. Bennett.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-243050. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report CO-87-2 (WRD/HD-88/250), 1988. 394p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for Colorado for the 1987 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report (Volumes 1 and 2) contains discharge records for 319 gaging stations, stage and contents of 24 lakes and reservoirs, 5 partial-record low-flow stations, peak flow information for 34 crest-stage partial record stations, and 1 miscellaneous site; water quality for 115 gaging stations, 177 miscellaneous sites and for 14 observation wells. Six pertinent stations in bordering States also are included in this report. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-06306) (USGS)
W90-06307

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1988. VOLUME 1. MISSOURI RIVER BASIN, ARKANSAS RIVER BASIN, AND RIO GRANDE BASIN.
Geological Survey, Lakewood, CO. Water Resources Div.
R. C. Ugland, B. J. Cochran, J. L. Ebling, and R. D. Steger.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-190433/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report CO-88-1 (WRD/HD-89/228), 1989. 411p. Prepared in cooperation with the State of Colorado and other agencies.

Descriptors: *Colorado, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for Colorado for the 1988 water year consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs. This report (Volumes 1 and 2) contains discharge records for 310 gaging stations, stage and contents of 25 lakes and reservoirs, 5 partial-record low-flow stations, peak flow information for 40 crest-stage partial record stations, and 1 miscellaneous site; water quality for 114 gaging stations, 170 miscellaneous sites, and for 14 observation wells. Four pertinent stations in bordering states also are included. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-06306) (USGS)
W90-06308

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1985.
Geological Survey, Hartford, CT. Water Resources Div.
M. A. Cervione, L. A. Weiss, J. Bohr, and J. W. Bingham.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-227526/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report CT-85-1 (WRD/HD-87/220), 1987. 279p. Prepared in cooperation with the State of Connecticut and with other agencies.

Descriptors: *Connecticut, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Biological analysis, Chemical analysis, Estuaries, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Connecticut consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 46 gaging stations; tidal volume at 1 gaging station; tidal stage at 4 gaging stations; contents at 35 lakes and reservoirs; water quality at 39 gaging stations, 4 lakes and reservoirs, 2 harbors, 3 precipitation stations, and 21 wells; and water levels at 32 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Connecticut. (USGS)
W90-06309

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1986.
Geological Survey, Hartford, CT. Water Resources Div.
M. A. Cervione, L. A. Weiss, J. R. Bohr, and J. W.

Bingham.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-126288/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report CT-86-1 (WRD/HD-88/246), 1988. 263p. Prepared in cooperation with the State of Connecticut and with other agencies.

Descriptors: *Connecticut, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Biological analysis, Chemical analysis, Estuaries, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Connecticut consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 49 gaging stations; tidal volume at 1 gaging station; tidal stage at 4 gaging stations; contents at 35 lakes and reservoirs; water quality at 39 gaging stations, 4 lakes and reservoirs, 2 harbors, 3 precipitation stations, and 52 wells; and water levels at 38 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Connecticut. (See also W90-06309) (USGS)
W90-06310

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1987.
Geological Survey, Hartford, CT. Water Resources Div.
M. A. Cervione, L. A. Weiss, J. R. Bohr, and J. W. Bingham.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194575/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report CT-87-1 (WRD/HD-89/215), 1989. 295p. Prepared in cooperation with the State of Connecticut and with other agencies.

Descriptors: *Connecticut, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Biological analysis, Chemical analysis, Estuaries, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Connecticut consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 47 gaging stations; tidal volume at 1 gaging station; tidal stage at 4 gaging stations; contents at 35 lakes and reservoirs; water quality at 39 gaging stations, 4 lakes and reservoirs, 2 harbors, 3 precipitation stations, and 110 wells; and water levels at 38 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Connecticut. (See also W90-06310) (USGS)
W90-06311

WATER RESOURCES DATA FOR CONNECTICUT, WATER YEAR 1988.
Geological Survey, Hartford, CT. Water Resources Div.
M. A. Cervione, B. S. Davies, J. R. Bohr, and J. W. Bingham.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-235485/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report CT-88-1 (WRD/HD-89/267), 1989. 346p. Prepared in cooperation with the State of Connecticut and with other agencies.

Descriptors: *Connecticut, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Biological analysis, Chemical analysis, Estuaries, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Connecticut consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. Specifically, it contains: (1) discharge records for 47 streamflow-gaging stations, and for 1 tidal volume streamflow station; (2) stage-only records for 4 tidal-gaging stations; (3) content records for 35 lakes and reservoirs; (4) water-quality records for 14 streamflow-gaging stations, for 24 ungaged stream sites, for 1 tidal-gaging station, for 4 lakes and reservoirs, for 2 harbors, for 3 precipitation stations, and for 220 wells; and (5) water-level records for 38 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Connecticut. (See also W90-06311) (USGS)
W90-06312

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1982. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
J. Warren, W. Haire, T. Miller, and C. Price.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-180327/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report FL-82-2A (WRD/HD-84/040), 1984. 445p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1982 water year in Florida consist of continuous or daily discharge for 264 streams, periodic discharge for 41 streams, miscellaneous discharge for 71 streams, continuous or daily stage for 102 streams, periodic stage for 15 streams, peak discharge for 83 streams, and peak stage for 8 streams; continuous or daily elevations for 102 lakes, periodic elevations for 111 lakes; continuous groundwater levels for 420 wells, and periodic groundwater levels for 587 wells; and miscellaneous water level measurements for 2,794 wells; quality-of-water data for 327 surface-water sites and 791 wells. The data for south Florida include continuous or daily discharge for 82 streams, periodic discharge for 2 streams, peak discharge for 2 streams, continuous or daily stage for 60 streams, and periodic stage for 33 streams; continuous elevations for 10 lakes, and periodic elevations for 8 lakes; continuous groundwater levels for 180 wells, periodic groundwater levels for 120 wells, and miscellaneous water level measurements for 336 wells; quality of water for 141 surface water sites and for 292 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See also W90-06314) (USGS)
W90-06313

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1982. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
J. Warren, W. Haire, T. Miller, and C. Price.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-180335/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report FL-82-2B (WRD/HD-84/041), 1984. 276p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1982 water year in Florida consists of continuous or daily discharge for 264 streams, periodic discharge for 41 streams, miscellaneous discharge for 71 streams, continuous or daily stage for 102 streams, periodic stage for 15 streams, peak discharge for 83 streams, and peak stage for 8 streams; continuous or daily elevations for 102 lakes, periodic elevations for 111 lakes; continuous groundwater levels for 420 wells, and periodic groundwater levels for 587 wells; and miscellaneous water level measurements for 2,794 wells; quality-of-water data for 327 surface-water sites and 791 wells. The data for south Florida include continuous or daily discharge for 82 streams, periodic discharge for 2 streams, peak discharge for 2 streams, continuous or daily stage for 60 streams, and periodic stage for 33 streams; continuous elevations for 10 lakes, and periodic elevations for 8 lakes; continuous groundwater levels for 180 wells, periodic groundwater levels for 120 wells, and miscellaneous water level measurements for 336 wells; quality of water for 141 surface water sites and for 292 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See also W90-06313) (USGS)
W90-06314

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, C. Price, and R. Sonenshein.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172292/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report FL-84-2B (WRD/HD-87/206), 1986. 373p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams, and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, and periodic groundwater levels for 539 wells; and miscellaneous water level measurements for 2,039 wells; quality-of-water data for 200 surface-water sites and 596 wells. The data for south Florida include continuous or daily discharge for 74 streams, periodic discharge for 2 streams, peak discharge for 2 streams, continuous or daily stage for 76 streams, and periodic stage for 29 streams; continuous elevations for 18 lakes, and periodic elevations for 5 lakes; continuous groundwater levels for 180 wells, periodic groundwater levels for 130 wells, and miscellaneous water level measurements for 360 wells; quality of water for 40 surface water sites and for 310 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See also W90-06314) (USGS)
W90-06315

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, C. Price, R. E. Curtis, and C. Lietz.
Available from the National Technical Information

Service, Springfield, VA 22161, as PB89-180343/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-2A (WRD/HD-87/232), 1987. 258p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year in Florida consists of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams, and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, and periodic groundwater levels for 550 wells; and miscellaneous water level measurements for 2,588 wells; quality-of-water data for 239 surface-water sites and 699 wells. The data for south Florida include continuous or daily discharge for 73 streams, periodic discharge for 3 streams, peak discharge for 2 streams, continuous or daily stage for 71 streams, periodic stage for 1 stream, peak discharge for 27 streams, and peak stage for 27 streams; continuous elevations for 14 lakes, and periodic elevations for 4 lakes; continuous groundwater levels for 198 wells, periodic groundwater levels for 136 wells, and miscellaneous water level measurements for 521 wells; quality of water for 49 surface water sites and for 310 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06315 and W90-06317) (USGS)
W90-06316

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, C. Price, and R. S. Sonenshein.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-180350/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-2B (WRD/HD-87/250), 1987. 367p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year in Florida consist of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams, and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, and periodic groundwater levels for 550 wells; and miscellaneous water level measurements for 2,588 wells; quality-of-water data for 239 surface-water sites and 699 wells. The data for south Florida include continuous or daily discharge for 73 streams, periodic discharge for 3 streams, peak discharge for 2 streams, continuous or daily stage for 71 streams, periodic stage for 1 stream, peak discharge for 27 streams, and peak stage for 27 streams; continuous elevations for 14 lakes, and periodic elevations for 4 lakes; continuous groundwater levels for 198 wells, periodic groundwater levels for 136 wells, and miscellaneous water level measurements for 521 wells; quality of water for 49 surface water sites and 310 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See also W90-06316) (USGS)
W90-06317

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 1A. NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Orlando, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-118583/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-1A (WRD/HD-87/259), 1987. 242p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams, miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams, and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 476 wells, and periodic groundwater levels for 1,226 wells; and miscellaneous water level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for northeast Florida include continuous or daily discharge for 70 streams, periodic discharge for 9 streams, miscellaneous discharge for 21 streams, continuous or daily stage for 27 streams, periodic stage for 8 streams; peak discharge for 21 streams, and peak stage for 25 streams; continuous or daily elevations for 20 lakes, periodic elevations for 35 lakes; continuous groundwater levels for 40 wells, periodic groundwater levels for 105 wells, and miscellaneous water-level measurements for 589 wells; quality of water data for 19 surface-water sites and for 82 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06316 and W90-06319 thru W90-06324) (USGS)
W90-06318

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 1B. NORTHEAST FLORIDA - GROUND WATER.
Geological Survey, Orlando, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-202123/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-1B (WRD/HD-87/219), 1987. 214p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams, miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams, and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 476 wells, and periodic groundwater levels for 1,226 wells; and miscellaneous water-level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for northeast Florida include continuous or daily discharge for 70 streams, periodic discharge for 9 streams, miscellaneous discharge for 21 streams, continuous or daily stage for 27 streams, periodic stage for 8 streams; peak discharge for 21 streams, and peak stage for 25 streams; continuous or daily elevations for 20 lakes, periodic elevations for 35 lakes; continuous groundwater levels for 40 wells, periodic groundwater levels for 105 wells, and miscellaneous water-level measurements for 589 wells; quality of water data for 19 surface-water sites and for 82 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See also W90-06318 and W90-06320 thru W90-06324) (USGS)
W90-06319

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, and E. C. Price.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-197538/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-2A (WRD/HD-88/217), 1988. 260p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams, miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 476 wells, periodic groundwater levels for 1,226 wells; and miscellaneous water level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for south Florida include continuous or daily discharge for 71 streams, periodic discharge for 5 streams, peak discharge for 2 streams, continuous or daily stage for 23 streams, periodic stage for 2 streams; peak discharge for 6 streams, and peak stage for 2 streams; continuous elevations for 14 lakes, and periodic elevations for 5 lakes; continuous groundwater levels for 198 wells, periodic groundwater levels for 806 wells, and miscellaneous water-level measurements for 259 wells; quality of water for 38 surface-water sites and 511 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See also W90-06318 thru W90-06319 and W90-06321 thru W90-06324) (USGS)
W90-06320

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, R. S. Sonenshein, C. Lietz, and E. Workman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-236328/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-2B (WRD/HD-88/238), 1988. 394p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams,

miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams, and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 476 wells, and periodic groundwater levels for 1,226 wells; and miscellaneous water level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for south Florida include continuous or daily discharge for 71 streams, periodic discharge for 5 streams, peak discharge for 2 streams, continuous or daily stage for 23 streams, and periodic stage for 2 streams; peak discharge for 6 streams, and peak stage for 2 streams; continuous elevations for 14 lakes, and periodic elevations for 5 lakes; continuous groundwater levels for 198 wells, periodic groundwater levels for 806 wells, and miscellaneous water-level measurements for 259 wells; quality of water for 38 surface-water sites and 511 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06318 thru W90-06320 and W90-06322 thru W90-06324) (USGS)
W90-06321

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 3A. SOUTHWEST FLORIDA-SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
W. L. Fletcher, J. K. Ogle, J. L. Oberg, and J. M. Todd.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-165816. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-3A (WRD/HD-88/203), 1987. 397p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams, miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams, and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 476 wells, periodic groundwater levels for 1,226 wells, and miscellaneous water-level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for southwest Florida include continuous or daily discharge for 85 streams, periodic discharge for 21 streams, miscellaneous discharge for 7 streams, continuous or daily stage for 26 streams, periodic stage for 10 streams; peak discharge for 20 streams, and peak stage for 1 stream; continuous elevations for 30 lakes, and periodic elevations for 28 lakes; continuous groundwater levels for 25 wells, periodic groundwater levels for 146 wells, and miscellaneous water-level measurements for 722 wells; quality of water for 106 surface-water sites and 265 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06318 thru W90-06321 and W90-06323 thru W90-06324) (USGS)
W90-06322

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 3B. SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
W. L. Fletcher, J. K. Ogle, J. L. Oberg, and J. M. Todd.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-125646/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-3B (WRD/HD-87/236), 1986. 343p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams, miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 476 wells, periodic groundwater levels for 1,226 wells, and miscellaneous water-level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for southwest Florida include continuous or daily discharge for 85 streams, periodic discharge for 21 streams, miscellaneous discharge for 7 streams, continuous or daily stage for 26 streams, periodic stage for 10 streams, peak discharge for 20 streams, and peak stage for 1 stream; continuous elevations for 30 lakes and periodic elevations for 28 lakes; continuous groundwater levels for 25 wells, periodic groundwater levels for 146 wells, and miscellaneous water-level measurements for 722 wells; quality of water for 106 surface-water sites and 265 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06318 thru W90-06322 and W90-06324) (USGS)
W90-06323

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1986. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
P. E. Meadows, J. B. Martin, and P. R. Mixson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-117049/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report FL-86-4 (WRD/HD-87/245), 1987. 267p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year in Florida consist of continuous or daily discharge for 277 streams, periodic discharge for 38 streams, miscellaneous discharge for 34 streams, continuous or daily stage for 77 streams, periodic stage for 20 streams, peak discharge for 88 streams and peak stage for 69 streams; continuous or daily elevations for 69 lakes, periodic elevations for 72 lakes; groundwater levels for 476 wells, periodic groundwater levels for 1,226 wells, and miscellaneous water-level measurements for 1,570 wells; quality of water data for 188 surface-water sites and 878 wells. The data for northwest Florida include continuous or daily discharge for 51 streams, periodic discharge for 3 streams, miscellaneous discharge for 6 streams, continuous or daily stage for 1 stream, peak discharge for 41 streams, and peak stage for 41 streams; continuous elevations for 5 lakes, and periodic elevations for 4 lakes; continuous groundwater levels for 13 wells, and periodic groundwater levels for 169 wells, quality of water for 25 surface-water sites and 20 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06318 thru W90-06323) (USGS)
W90-06324

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 1A. NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-149660/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-1A (WRD/HD-89/211), 1988. 416p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year in Florida consist of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams, and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; continuous groundwater levels for 477 wells, periodic groundwater levels for 562 wells, and miscellaneous water-level measurements for 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The data for northeast Florida include continuous or daily discharge for 125 streams, periodic discharge for 15 streams, miscellaneous discharge for 14 streams, continuous or daily stage for 45 streams, periodic stage for 27 streams; peak discharge for 26 streams, and peak stage for 27 streams; continuous or daily elevations for 39 lakes, periodic elevations for 53 lakes; continuous groundwater levels for 81 wells, periodic groundwater levels for 150 wells, and miscellaneous water-level measurements for 969 wells; quality of water data for 59 surface-water sites and 105 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06318 and W90-06326 thru W90-06331) (USGS)
W90-06325

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 1B. NORTHEAST FLORIDA - GROUND WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-117121/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-1B (WRD/HD-88/267), 1988. 346p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year in Florida consists of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams, and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; continuous groundwater levels for 477 wells, periodic groundwater levels for 562 wells; and miscellaneous water-level measurements for 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The data for northeast Florida include continuous or daily discharge for 125 streams, periodic discharge for 15 streams, miscellaneous discharge for 14 streams, continuous or daily stage for 45 streams, periodic stage for 27 streams; peak discharge for 26 streams, and peak stage for 27 streams; continuous or daily elevations for 39 lakes, periodic elevations for 53 lakes; con-

tinuous groundwater levels for 81 wells, periodic groundwater levels for 150 wells, and miscellaneous water-level measurements for 969 wells; quality of water data for 59 surface-water sites and 105 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 and W90-06327 thru W90-06331) (USGS)
W90-06326

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, E. C. Price, and C. Lietz.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-126304/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-2A (WRD/HD-88/265), 1988. 174 p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Florida, *Data collections, *Hydrologic data, *Surface water, *Groundwater, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis, Elevation, Wells.

Water resources data for the 1987 water year in Florida consist of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; continuous groundwater levels for 477 wells, and periodic groundwater levels for 562 wells; and miscellaneous water level measurements 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The data for south Florida include continuous or daily discharge for 47 streams, periodic discharge for 2 streams, peak discharge for 4 streams, miscellaneous discharge for 8 streams, continuous or daily stage for 63 streams, periodic stage for 16 streams; peak discharge for 3 streams, and peak stage for 12 streams; continuous elevations for 5 lakes; continuous groundwater levels for 169 wells, periodic groundwater levels for 213 wells, and miscellaneous water-level measurements for 388 wells; quality of water for 10 surface-water sites and 521 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 thru W90-06326 and W90-06328 thru W90-06331) (USGS).
W90-06327

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, R. S. Sonenshein, C. Lietz, and E. Workman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-174387/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-2B (WRD/HD-89/208), 1988. 354p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year in Florida consist of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams, and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; continuous groundwater levels for 477 wells, periodic groundwater levels for 562 wells; and miscellaneous water level measurements for 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The data for south Florida include continuous or daily discharge for 47 streams, periodic discharge for 2 streams, peak discharge for 4 streams, continuous or daily stage for 63 streams, periodic stage for 16 streams; peak discharge for 3 streams, and peak stage for 12 streams; continuous elevations for 1 lake, and periodic elevations for 5 lakes; continuous groundwater levels for 169 wells, periodic groundwater levels for 213 wells, and miscellaneous water-level measurements for 388 wells; quality of water for 10 surface-water sites and for 521 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 thru W90-06327 and W90-06329 thru W90-06331) (USGS)
W90-06328

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 3A. SOUTHWEST FLORIDA-SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
W. L. Fletcher, R. K. White, V. T. Coston, and J. M. Todd.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-113310/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-3A (WRD/HD-88/254), 1988. 300p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year in Florida consist of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; continuous groundwater levels for 477 wells, and periodic groundwater levels for 562 wells; and miscellaneous water-level measurements for 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The surface water data for southwest Florida include continuous or daily discharge for 61 streams, periodic discharge for 5 streams, miscellaneous discharge for 4 streams, continuous daily stage for 22 streams, periodic stage for 2 streams; peak discharge for 16 streams, continuous daily tide stage for 10 sites, continuous elevations for 22 lakes and periodic elevations for 16 lakes, and quality of water for 80 surface-water sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 thru W90-06328 and W90-06330 thru W90-06331) (USGS)
W90-06329

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 3B. SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tampa, FL. Water Resources Div.
W. L. Fletcher, R. K. White, J. L. Oberg, and J. M. Todd.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-217476. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-3B (WRD/HD-88/219), 1988. 340p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year in Florida consist of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; continuous groundwater levels for 477 wells, and periodic groundwater levels for 562 wells and miscellaneous water-level measurements for 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The groundwater data for southwest Florida include records for continuous groundwater elevations at 189 wells; periodic groundwater elevations at 108 wells; miscellaneous groundwater elevations at 823 wells; and water quality at 279 groundwater sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 thru W90-06329 and W90-06331) (USGS)
W90-06330

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1987. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
P. E. Meadows, J. B. Martin, and P. R. Mixson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128672/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report FL-87-4 (WRD/HD-88/280), 1988. 265p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year in Florida consist of continuous or daily discharge for 320 streams, periodic discharge for 38 streams, miscellaneous discharge for 29 streams, continuous or daily stage for 94 streams, periodic stage for 48 streams, peak discharge for 76 streams and peak stage for 69 streams; continuous or daily elevations for 80 lakes, periodic elevations for 74 lakes; groundwater levels for 477 wells, periodic groundwater levels for 562 wells, and miscellaneous water-level measurements for 2,886 wells; quality of water data for 223 surface-water sites and 900 wells. The data for northwest Florida include continuous or daily discharge for 49 streams, periodic discharge for 4 streams, miscellaneous discharge for 6 streams, continuous or daily stage for 9 streams, peak discharge for 30 streams, and peak stage for 30 streams; continuous elevations for 5 lakes, and periodic elevations for 4 lakes; continuous groundwater levels for 16 wells, and periodic groundwater levels for 70 wells, quality of water for 22 surface-water sites and 20 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 thru W90-06330) (USGS)
W90-06331

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 1A. NORTHEAST FLORIDA - SURFACE WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-207617/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-1A (WRD/HD-89/239), 1989. 440p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consist of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams, continuous daily tide stage for 8 streams, and peak stage for 84 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, periodic groundwater levels for 1,620 wells, and miscellaneous water-level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The data for northeast Florida include continuous or daily discharge for 132 streams, periodic discharge for 15 streams, miscellaneous discharge for 14 streams, continuous or daily stage for 45 streams, periodic stage for 27 streams; peak discharge for 26 streams, and peak stage for 27 streams; continuous or daily elevations for 39 lakes, periodic elevations for 53 lakes; continuous groundwater levels for 81 wells, periodic groundwater levels for 150 wells, and miscellaneous water-level measurements for 970 wells; quality of water data for 59 surface-water sites and 100 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06325 and W90-6333 thru W90-06338) (USGS)
W90-06332

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 1B. NORTHEAST FLORIDA - GROUND WATER.
Geological Survey, Altamonte Springs, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-168165/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-1B (WRD/HD-89/213), 1988. 396p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consist of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams, continuous daily tide stage for 8 streams, and peak stage for 84 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, and periodic groundwater levels for 1,620 wells, and miscellaneous water level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The data for northeast Florida include continuous or daily discharge for 132 streams, periodic discharge for 15 streams, miscellaneous discharge for 14 streams, continuous or daily stage for 45 streams, periodic stage for 27 streams; peak discharge for 26 streams, and peak stage for 27 streams; continuous or daily elevations for 39 lakes, periodic elevations for 53 lakes; continuous groundwater levels for 81 wells, periodic groundwater levels for 150 wells, and miscellaneous water-level measurements for 970 wells; quality of water data for 59 surface-water sites and 100 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06332 and W90-06334 thru W90-06338) (USGS)
W90-06333

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 2A. SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, E. C. Price, A. Lietz, and E. Workman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB8-228654/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-2A (WRD/HD-89/234), 1989. 210p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consist of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams, continuous daily tide stage for 8 streams, and peak stage for 84 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, periodic groundwater levels for 1,620 wells; and miscellaneous water-level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The data for south Florida include continuous or daily discharge for 65 streams, periodic discharge for 2 streams, peak discharge for 4 streams, continuous or daily stage for 82 streams, periodic stage for 16 streams; peak discharge for 2 streams, and peak stage for 12 streams; continuous elevations for 1 lake and periodic elevations for 5 lakes; continuous groundwater levels for 179 wells, periodic groundwater levels for 298 wells, and miscellaneous water-level measurements for 250 wells; quality of water for 6 surface-water sites and 558 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06332 thru W90-6333 and W90-06338) (USGS)
W90-06334

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 2B. SOUTH FLORIDA - GROUND WATER.
Geological Survey, Miami, FL. Water Resources Div.
W. J. Haire, and C. Lietz.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-228662/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-2B (WRD/HD-89/220), 1989. 369p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consist of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams, continuous daily tide stage for 8 streams, and peak stage for 84 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, periodic groundwater levels for 1,620 wells, and miscellaneous water level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The data for south Florida include continuous or daily discharge for 65 streams, periodic discharge for 2 streams, peak discharge for 4 streams, continuous or daily stage for 82 streams, periodic stage for 16 streams; peak discharge for 2 streams, and peak stage for 12 streams; continuous elevations for 1 lake, and periodic elevations for 5 lakes; continuous groundwater levels for 179 wells, periodic groundwater levels for 298 wells, and miscellaneous water-level measurements for 250 wells; quality of water for 6 surface-water sites and 558 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06332 thru W90-06334 and W90-06336 thru W90-06338) (USGS)
W90-06335

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 3A. SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tampa, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194930/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-3A (WRD/HD-89/236), 1989. 290p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consists of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams and peak stage for 84 streams; continuous daily tide stage for 10 sites, continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, and periodic groundwater levels for 1,620 wells, and miscellaneous water-level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The surface water data for southwest Florida include continuous or daily discharge for 59 streams, periodic discharge for 5 streams, miscellaneous discharge for 4 streams, continuous daily stage for 25 streams, periodic stage for 2 streams, peak discharge for 15 streams, continuous daily tide stage for 10 sites, continuous elevations for 22 lakes, and periodic elevations for 16 lakes, and quality of water for 64 surface-water sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06332 thru W90-06335 and W90-06337 thru W90-0633) (USGS)
W90-06336

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 3B. SOUTHWEST FLORIDA - GROUND WATER.
Geological Survey, Tampa, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194948/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-3B (WRD/HD-89/222), 1989. 311p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consists of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams, continuous daily tide stage for 8 sites, and peak stage for 84

streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, and periodic groundwater levels for 1,620 wells and miscellaneous water-level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The groundwater data for southwest Florida include continuous groundwater elevations at 203 wells; periodic groundwater elevations at 125 wells; miscellaneous groundwater elevations at 831 wells; and water quality at 237 groundwater sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06332 thru W90-06336 and W90-06338) (USGS)
W90-06337

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1988. VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
P. E. Meadows, J. B. Martin, and P. R. Mixson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203491/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report FL-88-4 (WRD/HD-89/233), 1989. 264p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year in Florida consist of continuous or daily discharge for 338 streams, periodic discharge for 34 streams, miscellaneous discharge for 28 streams, continuous or daily stage for 152 streams, periodic stage for 29 streams, peak discharge for 71 streams, continuous daily tide stage for 8 streams, and peak stage for 84 streams; continuous or daily elevations for 73 lakes, periodic elevations for 72 lakes; continuous groundwater levels for 490 wells, periodic groundwater levels for 1,620 wells; and miscellaneous water-level measurements for 2,678 wells; quality of water data for 158 surface-water sites and 884 wells. The data for northwest Florida include continuous or daily discharge for 52 streams, periodic discharge for 7 streams, continuous or daily stage for 11 streams, peak discharge for 26 streams, and peak stage for 26 streams; continuous elevations for 5 lakes, and periodic elevations for 4 lakes; continuous groundwater levels for 12 wells, and periodic groundwater levels for 80 wells, and miscellaneous water-level measurements for 55 wells; quality of water for 28 surface-water sites and 22 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06332 thru W90-06337) (USGS)
W90-06338

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1985.
Geological Survey, Doraville, GA. Water Resources Div.
W. R. Stokes, T. W. Hale, J. L. Pearman, and G. R. Buell.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172300. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report GA-85-1 (WRD/HD-86/264), 1986. 389p. Prepared in cooperation with the State of Georgia and with other Federal agencies.

Descriptors: *Data collections, *Georgia, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wells, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Georgia consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records of 109 gaging stations; stage for 11 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 109 continuing-record stations; peak stage and discharge only for 121 crest-stage partial-record stations and 6 miscellaneous sites; and water levels of 27 observation wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Georgia. (USGS)
W90-06339

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1986.
Geological Survey, Doraville, GA. Water Resources Div.
W. R. Stokes, T. W. Hale, and G. R. Buell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-180419/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report GA-86-1 (WRD/HD-88/207), 1987. 446p. Prepared in cooperation with the State of Georgia and with other Federal agencies.

Descriptors: *Data collections, *Georgia, *Groundwater, *Hydrologic data, *Precipitation, *Surface water, *Water quality, *Wells, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Georgia consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; groundwater levels; and precipitation quality. This report contains discharge records of 107 gaging stations; stage for 13 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 111 continuing-record stations; peak stage and discharge only for 119 crest-stage partial-record stations and 30 miscellaneous sites; base-flow discharge measurements at 236 miscellaneous sites; water levels of 26 observation wells and water quality for 4 precipitation-quality sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Georgia. (See also W90-06339) (USGS)
W90-06340

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1987.
Geological Survey, Doraville, GA. Water Resources Div.
W. R. Stokes, T. W. Hale, R. D. McFarlane, and G. R. Buell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-102586/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report GA-87-1 (WRD/HD-88/264), 1988. 424p. Prepared in cooperation with the State of Georgia and with other Federal agencies.

Descriptors: *Data collections, *Georgia, *Groundwater, *Hydrologic data, *Precipitation, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Georgia consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; groundwater levels; and precipitation quality. This report contains discharge records of 115 gaging stations; stage for 17 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 111 continuing-record stations; water quality for 1 miscellaneous station; peak stage and discharge only for 105 crest-stage partial-record stations and 30 miscellaneous sites; water levels of 26 observation wells and water quality for 1 precipitation quality site. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Georgia. (See also W90-06340) (USGS)
W90-06341

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1988.
Geological Survey, Doraville, GA. Water Resources Div.
W. R. Stokes, R. D. McFarlane, and G. R. Buell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-224703/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report GA-88-1 (WRD/HD-89/237), 1989. 438p. Prepared in cooperation with the State of Georgia and with other Federal agencies.

Descriptors: *Data collections, *Georgia, *Groundwater, *Hydrologic data, *Precipitation, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year for Georgia consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; groundwater levels; and precipitation quality. This report contains discharge records of 114 gaging stations; stage for 19 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 107 continuing-record stations; water quality for 4 miscellaneous stations; peak stage and discharge only for 76 crest-stage partial-record stations and 8 miscellaneous sites; base-flow discharge measurements at 149 miscellaneous sites; water levels of 26 observation wells; and water quality for 1 precipitation quality site. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Georgia. (See also W90-06341) (USGS)
W90-06342

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1985. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-202131/AS. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report HI-85-02 (WRD/HD-87/218), 1987. 142p. Prepared in cooperation with the Governments of Guam, Northern Mariana Islands, Federated States of Micronesia, Palau Islands, American Samoa, and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pacific Ocean, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for other Pacific areas consist of records of stage, discharge, and water quality of streams and springs; stage of 2 lakes and a reservoir; and water levels and water quality in wells. This report contains discharge records for 31 gaging stations; stage only record for 3 gaging stations; water quality for 8 gaging stations; 6 partial-record stations; water temperature for 31 gaging stations; and water levels for 35 observation wells and water quality for 110 groundwater sites. Also included are 19 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Governments and Federal agencies in other Pacific areas. (USGS)
W90-06343

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1986. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Re-

sources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-190657/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report HI-86-1 (WRD/HD-88/213), 1988. 283p. Prepared in cooperation with the State of Hawaii and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hawaii, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Hawaii and other Pacific Areas consist of records of stage, discharge, and water quality of streams and springs; and water levels and water quality in wells. This report, volume 1, contains discharge records for 83 gaging stations; water quality for 13 gaging stations, 73 partial-record flow stations, and 172 wells; and water levels for 40 observations wells. Also included are 107 crest-stage partial-record stations and 10 low-flow partial record stations. Additional water data were collected at various sites, not part of the systematic data collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and other agencies in Hawaii. (See W90-06343 and W90-06345) (USGS)
W90-06344

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1986. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-232327/AS. Price codes: A07 in paper copy, A01 in microfiche. USGS Water-Data Report HI-86-2 (WRD/HD-88/239), 1988. 126p. Prepared in cooperation with the Governments of Guam, Northern Mariana Islands, Federated States of Micronesia, Palau Islands, American Samoa, and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pacific Ocean, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for other Pacific areas consist of records of stage, discharge, and water quality of streams and springs; stage of 2 lakes and a reservoir; and water levels and water quality in wells. This report contains discharge records for 29 gaging stations; stage only record for 3 gaging stations; water quality for 8 gaging stations; 5 partial-record stations; water temperature for 28 gaging stations; and water levels for 35 observation wells and water quality for 81 groundwater sites. Also included are 8 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Governments and Federal agencies in other Pacific areas. (See also W90-06344) (USGS)
W90-06345

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1987. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, J. J. S. Yee, and J. A. Domingo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-139596/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report HI-87-1 (WRD/HD-89/204), 1988. 260p. Prepared in cooperation with the State of Hawaii and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hawaii, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Hawaii and other Pacific Areas consist of records of stage, discharge, and water quality of streams and springs; and water levels and water quality in wells. This report, volume 1, contains discharge records for 84 gaging stations; water quality for 14 gaging stations, 53 partial-record flow stations, and 184 wells; and water levels for 41 observations wells. Also included are 107 crest-stage partial-record stations and 10 low-flow partial record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and other agencies in Hawaii. (See W90-06344 and W90-06347) (USGS)
W90-06346

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1987. VOLUME 2.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-134993/AS. Price codes: A06 in paper copy, A01 in microfiche. USGS Water-Data Report HI-87-2 (WRD/HD-88/277), 1988. 108p. Prepared in cooperation with the Governments of Guam, Northern Mariana Islands, Federated States of Micronesia, Palau Islands, American Samoa, and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pacific Ocean, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for other Pacific areas consist of records streamflow and stage of 2 lakes and a reservoir; and water levels and water quality in wells. This report contains discharge records for 26 gaging stations; stage only records for 3 gaging stations; water temperature for 26 gaging stations; and water levels for 36 observations wells and water quality for 64 groundwater sites. Also included are 12 low-flow and 2 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Governments and Federal agencies in other Pacific areas. (See also W90-06346) (USGS)
W90-06347

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1985.
Geological Survey, Boise, ID. Water Resources Div.
W. A. Harenberg, H. G. Sisco, I. O'Dell, and S. C. Cordes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-208989/AS. Price codes: A99 in paper copy, A01 in microfiche. USGS Water-Data Report ID-85-1 (WRD/HD-87/215), 1986. 633p. Prepared in cooperation with the State of Idaho and with other agencies.

Descriptors: *Idaho, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Flow rates, Gaging stations, Lakes, Reservoirs, Chemical analysis, Sediments, Water temperature, Sampling sites, Water level, Water analysis.

Water resources data for the 1985 water year for Idaho consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records of 211 gaging stations; stage only records for 2 gaging stations; stage only for 8 lakes and reservoirs; contents only for 21 lakes and reservoirs; water quality for 19 gaging stations and 85 wells; and water levels for 415 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Idaho, adjacent States, and Canada. (USGS)
W90-06348

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1986.
Geological Survey, Boise, ID. Water Resources Div.
W. A. Harenberg, M. L. Jones, I. O'Dell, and S. C. Cordes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-211438/AS. Price codes: A99 in paper copy, E04 in microfiche. USGS Water-Data Report ID-86-1 (WRD/HD-88/216), 1987. 682p. Prepared in cooperation with the State of Idaho and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Idaho, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Idaho consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 248 gaging stations; stage only records for 2 gaging stations; stage only for 13 lakes and reservoirs; contents only for 23 lakes and reservoirs; water quality for 24 gaging stations and 52 wells; and water levels for 516 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Idaho, adjacent States, and Canada. (See also W90-06348) (USGS)
W90-06349

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1987.
Geological Survey, Boise, ID. Water Resources Div.
W. A. Harenberg, M. L. Jones, I. O'Dell, and S. C. Cordes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-131353/AS. Price codes: A99 in paper copy, E04 in microfiche. USGS Water-Data Report ID-87-1 (WRD/HD-88/278), 1988. 655p. Prepared in cooperation with the State of Idaho and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Idaho, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Idaho consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 230 gaging stations; stage only records for 2 gaging stations; stage only for 11 lakes and reservoirs; contents only for 25 lakes and reservoirs; water quality for 24 gaging stations and 52 wells; and water levels for 467 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperat-

ing State and Federal agencies in Idaho, adjacent States, and Canada. (See also W90-06349) (USGS)
W90-06350

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1988.
Geological Survey, Boise, ID. Water Resources Div.
W. A. Harenberg, M. L. Jones, I. O'Dell, and S. C. Cordes.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203293. Price codes: A99 in paper copy, E04 in microfiche. USGS Water-Data Report ID-88-1 (WRD/HD-89/226), 1989. 669p. Prepared in cooperation with the State of Idaho and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Idaho, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Idaho consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; discharge of irrigation diversions; and water levels and water quality of groundwater. This report contains discharge records for 208 stream-gaging stations; 36 irrigation diversions; stage only records for 2 stream-gaging stations; stage only for 8 lakes and reservoirs; contents only for 23 lakes and reservoirs; water quality for 25 stream-gaging stations, 64 wells, and 1 lake; and water levels for 452 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Idaho, adjacent States, and Canada. (See also W90-06350) (USGS)
W90-06351

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1986. VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
R. L. Stahl, K. K. Fitzgerald, T. E. Richards, and P. D. Hayes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-117189/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report IL-86-1 (WRD/HD-87/248), 1987. 482p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 76 streamflow-gaging stations and for 9 crest-stage, partial-record streamflow stations; (2) stage for 19 streamflow-gaging stations; (3) stage and contents for 3 lakes and reservoirs; and (4) water quality records for 48 streamflow-gaging stations, 3 of which include sediment discharge, and for 66 ungaged stream sites. (See also W90-06353) (USGS)
W90-06352

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1986 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
K. K. Fitzgerald, P. D. Hayes, T. E. Richards, and R. L. Stahl.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-117197/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report IL-86-2 (WRD/HD-87/249), 1987. 415p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 77 streamflow-gaging stations and for 14 crest-stage, partial-record streamflow stations; (2) stage for 2 streamflow-gaging stations and 3 lake stations; (3) water quality records for 44 streamflow-gaging stations, 6 of which include sediment discharge, and for 49 ungaged stream sites; and (4) water-level records for 3 observation wells. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. (See also W90-06352) (USGS)
W90-06353

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1987 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
R. L. Stahl, K. K. Fitzgerald, T. E. Richards, and P. D. Hayes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-111728/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report IL-87-1 (WRD/HD-88/268), 1988 482p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 73 streamflow-gaging stations and for 10 crest-stage, partial-record streamflow stations; (2) stage for 18 streamflow-gaging stations; (3) stage and contents for 3 lakes and reservoirs; and (4) water quality records for 44 streamflow-gaging stations, 3 of which include sediment discharge, and for 70 ungaged stream sites. (See W90-06352 and W90-06355) (USGS)
W90-06354

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1987 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
K. K. Fitzgerald, P. D. Hayes, T. E. Richards, and R. L. Stahl.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-111736/AS. Price codes: A22 in paper copy, A01 in microfiche. USGS Water-Data Report IL-87-2 (WRD/HD-88/269), 1988. 492p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 76 streamflow-gaging stations and for 14 crest-stage, partial-record streamflow stations; (2) stage for 3 streamflow-gaging stations and for 3 lake stations; (3) water quality records for 45 streamflow-gaging stations, 2 of which include sediment discharge, and for 49 ungaged stream sites; and (4) water-level records for 3 observation wells. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements and miscellaneous water quality analyses. (See also W90-06534) (USGS)
W90-06355

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1988 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
R. L. Stahl, R. H. Coupe, T. E. Richards, and P. D. Hayes.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203277. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report IL-88-1 (WRD/HD-89/248), 1989 413p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 70 streamflow-gaging stations and for 10 crest-stage, partial-record streamflow stations; (2) stage for 18 streamflow-gaging stations; (3) stage and contents for 3 lakes and reservoirs; and (4) water quality records for 46 streamflow-gaging stations, 3 of which include sediment discharge, and for 40 ungaged stream sites. (See also W90-06354 and W90-06357) (USGS)
W90-06356

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1988 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
R. H. Coupe, P. D. Hayes, T. E. Richards, and R. L. Stahl.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-203285/AS. Price codes: A24 in paper copy, A01 in microfiche. USGS Water-Data Report IL-88-2 (WRD/HD-89/249), 1989. 556p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 77 streamflow-gaging stations and for 14 crest-stage partial-record streamflow stations; (2) stage for 3 streamflow-gaging stations and for 3 lake stations; (3) water quality records for 47 streamflow-gaging stations, 1 of which includes sediment discharge, and for 32 ungaged stream sites; and (4) water-level records for 3 observation wells. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous discharge measurements and miscellaneous water quality analyses. (See also W90-06356) (USGS)

W90-06357

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1985.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. R. Glatfelter, R. E. Thompson, and G. E. Nell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-208997/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report IN-85-1 (WRD/HD-87/216), 1986. 303p. Prepared in cooperation with the State of Indiana and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Indiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Indiana consist of records of stage, discharge, and water quality of streams; stage and contents of 1 reservoir; and water levels in wells. This report contains discharge records for 185 gaging stations, stage and contents for 1 reservoir, water temperature for 1 gaging station, water quality for 5 gaging stations, and water levels for 84 observation wells. Also included are 25 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Indiana. (USGS)
W90-06358

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1986.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. R. Glatfelter, R. E. Thompson, and G. E. Nell.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-165808. Price codes: A20 in papercopy, A01 in microfiche. USGS Water-Data Report IN-86-1 (WRD/HD-88/202), 1987. 441p. Prepared in cooperation with the State of Indiana and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Indiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Indiana consist of records of stage, discharge, and water quality of streams; reservoir stage and contents; and water levels in lakes and wells. This report contains discharge records for 189 stream-gaging stations, stage for stream station, stage and contents for 1 reservoir, water quality for 5 streams, and water levels for 79 lakes and 94 observation wells. Also included are records of peak flow for 24 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Indiana. (See also W90-06358) (USGS)
W90-06359

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1987.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. R. Glatfelter, R. E. Thompson, and G. E. Nell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-100424/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report IN-87-1 (WRD/HD-88/255), 1988. 433p. Prepared in cooperation with the State of Indiana and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Indiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Indiana consist of records of discharge, stage, and water quality of streams and wells; reservoir stage and contents; and water levels in lakes and wells. This report contains discharge records for 187 stream-gaging stations, stage for 1 stream station, stage and contents for 1 reservoir, water quality for 3 streams and 3 observation wells, and water levels for 79 lakes and 87 observation wells. Also included are records of peak flows for 23 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Indiana. (See also W90-06359) (USGS)
W90-06360

WATER RESOURCES DATA FOR INDIANA, WATER YEAR 1988.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. R. Glatfelter, R. E. Thompson, and G. E. Nell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-148206/AS. Price codes: A15 in paper copy, A02 in microfiche. USGS Water-Data Report IN-88-1 (WRD/HD-89/282), 1989. 331p. Prepared in cooperation with the State of Indiana and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Indiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Indiana consist of records of stage, discharge, and water quality of streams and wells; reservoir stage and contents; and water levels in lakes and wells. This report contains records of discharge for 176 stream-gaging stations, stage for 4 stream stations, stage and contents for 1 reservoir, water quality for 3 streams and 2 observation wells, and water levels for 79 lakes and 88 observation wells. Also included are records of peak flows for 23 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are shown as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey in Indiana in cooperation with State and Federal agencies. (See also W90-06360) (USGS)
W90-06361

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1986.
Geological Survey, Iowa City, IA. Water Resources Div.
N. B. Melcher, M. G. Detroy, W. J. Matthes, and R. A. Karsten.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-117031/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report IA-86-1 (WRD/HD-87/246), 1987. 333p. Prepared in cooperation with the State of Iowa and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Iowa, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Iowa consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; groundwater levels and groundwater quality. This report contains discharge records for 110 stream-gaging stations; stage and contents for 8 lakes and reservoirs; water quality for 8 stream-gaging stations; sediment records for 10 stream-gaging stations, water levels for 108 observation wells; and chemical analysis for 214 observation wells. Also included are 116 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are shown as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey in Iowa in cooperation with State and Federal agencies in Iowa. (USGS)
W90-06362

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1987.
Geological Survey, Iowa City, IA. Water Resources Div.
N. B. Melcher, R. W. Baebenroth, M. G. Detroy, R. A. Karsten, and W. J. Matthes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-252028/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report IA-87-1 (WRD/HD-88/252), 1988. 345p. Prepared in cooperation with the State of Iowa and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Iowa, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Iowa consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; groundwater levels and water quality of groundwater wells. This report contains discharge records for 112 stream-gaging stations; stage or contents for 8 lakes and reservoirs; water quality for 8 stream-gaging stations; sediment records for 10 stream-gaging stations, water levels for 112 observation wells; and chemical analysis for 197 municipal wells. Also included are 113 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are shown as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey in Iowa in cooperation with State and Federal agencies in Iowa. (See also W90-06362) (USGS)
W90-06363

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1988.
Geological Survey, Iowa City, IA. Water Resources Div.
N. B. Melcher, M. G. Detroy, R. A. Karsten, and W. J. Matthes.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-194559/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report IA-88-1 (WRD/HD-89/224), 1989. 377p. Prepared in cooperation with the State of Iowa and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Iowa, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Iowa consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; groundwater levels and water quality of groundwater wells. This report contains discharge records for 117 stream-gaging stations; stage or contents for 7 lakes and reservoirs; water quality for 9 stream-gaging stations; sediment records for 8 stream-gaging stations, water levels for 108 observation wells; and chemical analysis for 153 municipal wells. Also included are 113 crest-stage partial-record stations.

Additional water data were collected at various sites, not part of the systematic data-collection program, and are shown as miscellaneous discharge measurements and miscellaneous water quality analyses. (See also W90-06363) (USGS)
W90-06364

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984 VOLUME 1B: NORTHEAST FLORIDA - GROUNDWATER.
Geological Survey, Orlando, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-111175/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report FL-84-1B (WRD/HD-86/222), 1986. 168p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, periodic groundwater levels for 539 wells, and miscellaneous water level measurements for 2,039 wells; quality of water data for 200 surface water sites and 596 wells. The data for northeast Florida include continuous or daily discharge for 65 streams, periodic discharge for 7 streams, miscellaneous discharge for 21 streams, continuous or daily stage for 37 streams, peak discharge for 15 streams and peak stage for 8 streams; continuous or daily elevations for 22 lakes, periodic elevations for 33 lakes; continuous groundwater levels for 31 wells, periodic groundwater levels for 90 wells, and miscellaneous water level measurements for 563 wells; quality of water data for 15 surface water sites and 45 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04554 and W90-06366 thru W90-06369) (USGS)
W90-06365

WATER RESOURCES DATA FLORIDA, WATER YEAR 1984, VOLUME 2A: SOUTH FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
W. J. Haire, and C. Price.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-137071. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report FL-84-2A (WRD/HD-86/244), 1986. 282p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, periodic groundwater levels for 539 wells, and miscellaneous water level measurements for 2,039 wells; quality of water data for 200 surface water sites and 596 wells. The data for south Florida include continuous or daily discharge for 74 streams, periodic discharge for 2 streams, peak discharge for 2 streams, continuous or daily stage for 76 streams; and periodic stage for 29 streams; continuous elevations for 18 lakes and periodic elevations for 5 lakes; continuous groundwater levels for 180 wells, periodic groundwater levels for 130 wells, and miscellaneous water level measurements for 360 wells; quality of water for 40 surface water sites and 310 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04554, W90-06365 and W90-06367 thru W90-06369) (USGS)
W90-06366

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984, VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. T. Mycyk, L. D. Fayard, W. L. Fletcher, and J. K. Ogle.
Available from the National Technical Information Service, Springfield, VA 22161. USGS Water-Data Report FL-84-3A (WRD/HD-86/207), 1986. 398p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, periodic groundwater levels for 539 wells, and miscellaneous water level measurements for 2,039 wells; quality of water data for 200 surface water sites and 596 wells. The data for southwest Florida include continuous or daily discharge for 81 streams, periodic discharge for 15 streams, miscellaneous discharge for 14 streams, peak discharge for 20 streams, continuous or daily stage for 31 streams; continuous elevations for 30 lakes and periodic elevations for 43 lakes; continuous groundwater levels for 231 wells, periodic groundwater levels for 199 wells, and miscellaneous water level measurements for 799 wells; quality of water for 117 surface water sites and 289 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04544, W90-06365, W90-06366, W90-06368, and W90-06369) (USGS)
W90-06367

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1984. VOLUME 3B: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. T. Mycyk, L. D. Fayard, W. L. Fletcher, and J. K. Ogle.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-105623/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report FL-84-3B (WRD/HD-86/208), 1986. 336p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, periodic groundwater levels for 539 wells, and miscellaneous water level measurements for 2,039 wells; quality of water data for 200 surface water sites and 596 wells. The data for southwest Florida include continuous or daily discharge for 81 streams, periodic discharge for 15 streams, miscellaneous discharge for 14 streams, peak discharge for 20 streams, continuous or daily stage for 31 streams; continuous elevations for 30 lakes and periodic elevations for 43 lakes; continuous groundwater levels for 231 wells, periodic groundwater levels for 199 wells, and miscellaneous water level measurements for 799 wells; quality of water for 117 surface water sites and 289 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04554, W90-06365 thru W90-06367, and W90-06369) (USGS)
W90-06368

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1984, VOLUME 4. NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
P. E. Meadow, J. B. Martin, and P. R. Mixson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-195724. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report FL-84-4 (WRD/HD-86/215), 1986. 240p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Groundwater, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Hydrologic data, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1984 water year in Florida consist of continuous or daily discharge for 251 streams, periodic discharge for 32 streams, miscellaneous discharge for 43 streams, continuous or daily stage for 92 streams, periodic stage for 31 streams, peak discharge for 60 streams and peak stage for 37 streams; continuous or daily elevations for 73 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 467 wells, periodic groundwater levels for 539 wells, and miscellaneous water level measurements for 2,039 wells; quality of water data for 200 surface water sites and 596 wells. The data for northwest Florida include continuous or daily discharge for 46 streams, periodic discharge for 7 streams, peak discharge for 19 streams and peak stage for 19 streams, continuous or daily stage for 4 streams; continuous elevations for 5 lakes and periodic elevations for 4 lakes; continuous groundwater levels for 25 wells, periodic groundwater levels for 87 wells, and miscellaneous water level measurements for 70 wells; quality of water for 27 surface water sites and 22 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04554 and W90-06365 thru W90-06368) (USGS)
W90-06369

WATER RESOURCES DATA - FLORIDA, WATER YEAR 1985, VOLUME 1A: NORTHEAST FLORIDA-SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-151734/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-1A (WRD/HD-86/266), 1986. 290p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water

quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Oklawaha River basin, Reservoirs, Sampling sites, Sediments, St Johns River basin, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1985 water year in Florida consist of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, periodic groundwater levels for 550 wells, and miscellaneous water level measurements for 2,588 wells; quality of water data for 239 surface water sites and 699 wells. The data for northeast Florida include continuous or daily discharge for 75 streams, periodic discharge for 9 streams, miscellaneous discharge for 21 streams, continuous or daily stage for 22 streams; periodic stage for 21 streams, peak discharge for 17 streams, and peak stage for 25 streams, continuous or daily elevations for 20 lakes, periodic elevations for 35 lakes; continuous groundwater levels for 40 wells, periodic groundwater levels for 103 wells, and miscellaneous water level measurements for 590 wells; quality of water for 19 surface water sites and 82 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-04554, W90-06365, and W90-06371 thru W90-06374) (USGS)
W90-06370

WATER RESOURCES DATA - FLORIDA, WATER YEAR 1985, VOLUME 1B: NORTHEAST FLORIDA - GROUNDWATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-111175. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-1B (WRD/HD-86/248), 1986. 232p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1985 water year in Florida consist of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, periodic groundwater levels for 550 wells, and miscellaneous water level measurements for 2,588 wells; quality of water data for 239 surface water sites and 699 wells. The data for northeast Florida include continuous or daily discharge for 75 streams, periodic discharge for 9 streams, miscellaneous discharge for 21 streams, continuous or daily stage for 22 streams; periodic stage for 21 streams, peak discharge for 17 streams, and peak stage for 25 streams, continuous or daily elevations for 20 lakes, periodic elevations for 35 lakes; continuous groundwater levels for 40 wells, periodic groundwater levels for 103 wells, and miscellaneous water level measurements for 590 wells; quality of water for 19 surface water sites and 82 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Florida. (See W90-06370 and W90-06372 thru W90-06374) (USGS)
W90-06371

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1985. VOLUME 3A: SOUTHWEST FLORIDA - SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. T. Mycyk, L. D. Fayard, and J. K. Ogle.
Available from National Technical Information Service, Springfield, VA 22161 as PB87-149969/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-3A (WRD/HD-87-205), 1986. 402p. Prepared in cooperation with the state of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Peace River basin, Reservoirs, Sampling sites, Sediments, Tampa Bay, Water analysis, Water level, Water temperature, Wells, Withlacoochee River basin.

Water resources data for the 1985 water year in Florida consist of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, periodic groundwater levels for 550 wells, and miscellaneous water level measurements for 2,588 wells; quality of water data for 239 surface water sites and 699 wells. The data for southwest Florida include continuous or daily discharge for 91 streams, periodic discharge for 23 streams, miscellaneous discharge for 57 streams, peak discharge for 20 streams, continuous or daily stage for 30 streams; continuous elevations for 50 lakes and periodic elevations for 39 lakes; continuous groundwater levels for 233 wells, periodic groundwater levels for 146 wells, and miscellaneous water level measurements for 1,477 wells; quality of water for 146 surface water sites and 287 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06370, W90-06371, W90-06373, and W90-06374) (USGS)
W90-06372

WATER RESOURCES DATA FOR FLORIDA WATER YEAR 1985. VOLUME 3B: SOUTHWEST FLORIDA-GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
R. T. Mycyk, L. D. Fayard, W. L. Fletcher, and J. K. Ogle.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-151742/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-3B (WRD/HD-86/246), 1986. 345p. Prepared in cooperation with the State of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Hydrologic data, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water-resources data for the 1985 water year in Florida consist of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, periodic groundwater levels for 550 wells, and miscellaneous water level measurements for 2,588 wells; quality of water data for 239 surface water sites and 699 wells. The data for southwest Florida include continuous or daily discharge for 91 streams, periodic discharge for 23 streams, miscellaneous discharge for 57 streams, peak discharge for 20 streams, continuous or daily stage for 30 streams; continuous elevations for 50 lakes and periodic levels for 39 lakes; continuous groundwater levels for 233 wells, periodic groundwater levels for 146 wells, and miscellaneous water level measurements for 1,477 wells; quality of water for 146 surface water sites and 287 wells. These data represent the National Water Data System records collected by the U. S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06370 thru W90-06372 and W90-06374) (USGS)
W90-06373

WATER RESOURCES DATA, FLORIDA, WATER YEAR 1985 VOLUME 4: NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
P. E. Meadows, J. B. Martin, and P. R. Mixson.
Available from National Technical Information Service, Springfield, VA 22161 as PB87-151759/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report FL-85-4 (WRD/HD-87/204), 1986. 317p. Prepared in cooperation with the state of Florida and other agencies.

Descriptors: *Data collections, *Florida, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Elevation, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year in Florida consist of continuous or daily discharge for 285 streams, periodic discharge for 38 streams, miscellaneous discharge for 110 streams, continuous or daily stage for 124 streams, periodic stage for 32 streams, peak discharge for 98 streams and peak stage for 87 streams; continuous or daily elevations for 89 lakes, periodic elevations for 82 lakes; continuous groundwater levels for 473 wells, periodic groundwater levels for 550 wells, and miscellaneous water level measurements for 2,588 wells; quality of water data for 239 surface water sites and 699 wells. The data for northwest Florida include continuous or daily discharge for 46 streams, periodic discharge for 3 streams, miscellaneous discharge for 30 streams, continuous or daily stage for 1 stream, peak discharge for 34 streams, and peak stage for 34 streams; continuous elevations for 5 lakes and periodic elevations for 4 lakes, continuous groundwater levels for 12 wells, and periodic groundwater levels for 165 wells; quality of water for 25 surface water sites and 20 wells. These data represent the National Water Data System records collected by the U. S. Geological Survey and cooperating local, state and federal agencies in Florida. (See W90-06370 thru W90-06373) (USGS)
W90-06374

WATER RESOURCES DATA FOR GEORGIA, WATER YEAR 1984.
Geological Survey, Doraville, GA. Water Resources Div.
W. R. Stokes, T. W. Hale, J. L. Pearman, and G. R. Buell.
Available from National Technical Information Service, Springfield, VA 22161, as PB86-127016. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report GA-85-1 (WRD/HD-85/259), 1985. 382p. Prepared in cooperation with the state of Georgia and with other Federal agencies.

Descriptors: *Data collections, *Georgia, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year in Georgia consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records of 108 gaging stations; stage for 11 gaging stations; stage and contents for 17 lakes and reservoirs; water quality for 14 continuous stations, 109 periodic stations and miscellaneous sites; peak stage and discharge only for 130 crest-stage partial-record stations and 44 miscellaneous sites; and water levels of 27 observation wells. These data represent that part of

the National Water Data System records collected by the U. S. Geological Survey and cooperating local, state and federal agencies in Georgia. (USGS)
W90-06375

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1984. VOLUME 1, HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from National Technical Information Service, Springfield, VA 22161, as PB86-130663. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report HI-84-01 (WRD/HD-85/247), 1985. 287p. Prepared in cooperation with the state of Hawaii and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hawaii, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year in Hawaii and other Pacific Areas consist of records of stage, discharge, and water quality of streams and springs; and water levels and water quality in wells. This report, Volume 1, contains discharge records for 96 gaging stations; water quality for 13 gaging stations, 102 partial-record flow stations, and 153 wells; and water levels for 39 observation wells. Also included are 108 crest-stage partial record stations and 21 low-flow partial-record stations. Additional water data collected at various sites, not part of the systematic data collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U. S. Geological Survey and cooperating State and Federal, and other agencies in Hawaii. (See also W90-06377) (USGS)
W90-06376

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1984. VOLUME 2. GUAM, NORTHERN MARIANA ISLANDS, FEDERATED STATES OF MICRONESIA, PALAU, AND AMERICAN SAMOA.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from National Technical Information Service, Springfield, VA 22161, as PB86-126869. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report HI-84-02 (WRD/HD-85/269), 1985. 152p.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pacific Ocean, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water level, Water temperature.

Volume 2 of water resources data for the 1984 water year for other Pacific areas consists of records of stage, discharge, and water quality of streams and springs; stage of 2 lakes and a reservoir; and water levels and water quality in wells. This report contains discharge records for 32 gaging stations; stage only records for 3 gaging stations; water quality for 14 gaging stations, 14 partial-record stations, water temperature for 32 gaging stations; and water levels for 37 observation wells; and water quality for 113 groundwater sites. Also included are 19 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U. S. Geological Survey and cooperating Governments and Federal agencies in other Pacific areas. (See also W90-07376) (USGS)
W90-06377

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1985. VOLUME 1: HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
S. S. Chinn, G. A. Tateishi, and J. J. S. Yee.
Available from National Technical Information Service, Springfield, VA 22161 as PB87-152666/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report HI-85-01 (WRD/HD-86/262), 1986. 302p. Prepared in cooperation with the state of Hawaii and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hawaii, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year in Hawaii and other Pacific Areas consist of records of stage, discharge, and water quality of streams and springs; and water levels and water quality in wells. This report, Volume 1, contains discharge records for 98 gaging stations; water quality for 13 gaging stations, 100 partial-record flow stations, and 154 wells; and water levels for 39 observation wells. Also included are 108 crest-stage partial record stations and 20 low-flow partial-record stations. Additional water data collected at various sites, not part of the systematic data collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U. S. Geological Survey and cooperating State and Federal, and other agencies in Hawaii. (See also W90-06376) (USGS)
W90-06378

WATER RESOURCES DATA FOR IDAHO, WATER YEAR 1984.
Geological Survey, Boise, ID. Water Resources Div.
R. W. Harper, H. G. Sisco, I. O'dell, and S. C. Cordes.
Available from National Technical Information Service, Springfield, VA 22161, as PB86-159290. Price codes: A24 in paper copy, A01 in microfiche. USGS Water-Data Report ID-84-01 (WRD/HD-85/268), 1985. 540p. Prepared in cooperation with the state of Idaho and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Idaho, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year in Idaho consist of records of stage, discharge, and water quality of streams stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 178 gaging stations; stage only records for 2 gaging stations; stage only for 9 lakes and reservoirs; contents only for 17 lakes and reservoirs; water quality for 22 gaging stations and 66 wells, and water levels for 420 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U. S. Geological Survey and cooperating State and Federal agencies in Idaho, adjacent States, and Canada. (USGS)
W90-06379

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1984 VOLUME 1. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
R. L. Stahl, K. K. Fitzgerald, T. E. Richards, and P. D. Hayes.
Available from National Technical Information Service, Springfield, VA 22161, as PB86-128568. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report IL-84-01 (WRD/HD-85/239), 1985. 447p. Prepared in cooperation with the state of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year in Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 75 gaging stations; stage at 17 gaging stations; stage and contents at 3 lakes and reservoirs; and water quality at 114 gaging stations. Also included are data for 10 crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements and analysis. These data together with the data in Volume 2 represent that part of the National Water Data System operated by the U. S. Geological Survey and cooperating State and Federal agencies in Illinois. (See also W90-06381) (USGS)
W90-06380

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1984 VOLUME 2. ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
K. K. Fitzgerald, P. D. Hayes, T. E. Richards, and R. L. Stahl.
Available from National Technical Information Service, Springfield, VA 22161. USGS Water-Data Report IL-84-2 (WRD/HD-85/240), 1985. 383p. Prepared in cooperation with the state of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year in Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 74 gaging stations; stage only at 2 gaging stations; stage only at 3 lakes stations; water quality at 94 gaging stations; and water levels at 3 observation wells. Also included are data for 15 crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements and analysis. These data together with the data in Volume 1 represent that part of the National Water Data System operated by the U. S. Geological Survey and cooperating State, local, and Federal agencies in Illinois. (See also W90-06380) (USGS)
W90-06381

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1985. VOLUME 1: ILLINOIS EXCEPT ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
R. L. Stahl, K. K. Fitzgerald, T. E. Richards, and P. D. Hayes.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-105631. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report IL-85-1 (WRD/HD-86/241), 1986. 444p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of

lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 74 streamflow-gaging stations and for 10 crest-stage, partial-record streamflow stations; (2) stage for 17 streamflow-gaging stations; (3) stage and contents for 3 lakes and reservoirs; and (4) water quality records for 48 streamflow-gaging stations, 3 of which include sediment discharge, and for 66 ungaged stream sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Illinois. (See W90-06380 and W90-06383) (USGS)
W90-06382

WATER RESOURCES DATA FOR ILLINOIS, WATER YEAR 1985 VOLUME 2. ILLINOIS RIVER BASIN.
Geological Survey, Urbana, IL. Water Resources Div.
K. K. Fitzgerald, P. D. Hayes, T. E. Richards, and R. L. Stahl.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-105649. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report IL-85-2 (WRD/HD-86/242), 1986. 397p. Prepared in cooperation with the State of Illinois and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Illinois, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Illinois consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains (1) discharge for 74 streamflow-gaging stations and for 15 crest-stage, partial-record streamflow stations; (2) stage for 2 streamflow-gaging stations and for 3 lake stations; (3) water quality records for 43 streamflow-gaging stations, 5 of which include sediment discharge, and for 50 ungaged stream sites; and (4) water-level records for 3 observation wells. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Illinois. (See also W90-06382) (USGS)
W90-06383

WATER RESOURCES DATA FOR INDIANA. WATER YEAR 1984.
Geological Survey, Indianapolis, IN. Water Resources Div.
D. R. Glatfelter, J. A. Stewart, and G. E. Nell.
Available from the National Technical Information Service, Springfield, VA 22161, PB86-163698. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report IN-84-1 (WRD/HD-85-044), 1985. 292p. Prepared in cooperation with the State of Indiana and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Indiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Indiana consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels in wells. This report contains discharge records for 185 gaging stations, stage and contents for 7 lakes and reservoirs, releases from 7 flood control reservoirs, water quality for 5 gaging stations, and water levels for 83 observation wells. Also included are 24 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Indiana. (USGS)
W90-06384

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1984.
Geological Survey, Iowa City, IA. Water Resources Div.
V. E. Miller, W. J. Matthes, M. G. Detroy, and R. E. Hansen.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-173077. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report IA-84-1 (WRD/HD-85-263), 1985. 263p. Prepared in cooperation with the State of Iowa and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Iowa, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Groundwater level, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Iowa consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; groundwater levels and groundwater quality. This report contains discharge records for 115 gaging stations, stage and contents for 7 lakes and reservoirs, water quality for 7 gaging stations, and water levels for 90 observation wells. Also included are 120 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, state and federal agencies in Iowa. (USGS)
W90-06385

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1984.
Geological Survey, Lawrence, KS. Water Resources Div.
C. O. Geiger, D. L. Lacock, L. R. Shelton, M. L. Penny, and C. E. Merry.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-166170. Price codes: A22 in paper copy, A01 in microfiche. USGS Water-Data Report KS-84-1 (WRD/HD-85/270), 1985. 500p. Prepared in cooperation with the State of Kansas and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kansas, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Kansas consist of records of stage, discharge, and water quality of streams; elevation, contents, and water quality of lakes or reservoirs; and water levels and water quality of groundwater wells. This report contains records for water discharge at 141 gaging stations; elevation and contents at 24 lakes or reservoirs; water quality at 50 gaging stations; and water levels at 436 observation wells and water quality at 231 wells. Also included are data for 91 high-flow, 9 low-flow, and 2 flood hydrograph partial-record stations; and 2 chemical quality of precipitation stations. Miscellaneous water-temperature data were collected at 151 measuring sites, and miscellaneous water quality data were collected at 85 sampling sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Kansas. (USGS)
W90-06386

WATER RESOURCES DATA FOR KANSAS WATER YEAR 1985.
Geological Survey, Lawrence, KS. Water Resources Div.
C. O. Geiger, D. L. Lacock, J. E. Putnam, B. L. Riche, and C. E. Merry.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-152351/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report KS-85-1 (WRD/HD-86/261), 1986. 478p. Prepared in cooperation with the State of Kansas and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kansas, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Kansas consist of records of stage, discharge, and water quality of streams; elevation, contents, and water quality of lakes or reservoirs; and water levels and water quality of groundwater wells. This report contains records for water discharge at 142 gaging stations; elevation and contents at 24 lakes or reservoirs; water quality at 46 gaging stations; and water levels at 1,496 observation wells and water quality at 235 wells. Also included are data for 92 high-flow, 9 low-flow, and 2 flood hydrograph partial-record stations; and 2 chemical-quality of precipitation stations. Miscellaneous water temperature data were collected at 142 measuring sites, and miscellaneous water quality data were collected at 31 sampling sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Kansas. (See also W90-06386) (USGS)
W90-06387

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1984.
Geological Survey, Louisville, KY. Water Resources Div.
J. M. Bettandorff, N. B. Melcher, C. J. Sholar, and J. L. Smoot.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-162526. Price codes: A17 in paper copy, A01 in microfiche USGS Water-Data Report WRD/HD-85/260, 1984. 368p. Prepared in cooperation with the State of Kentucky and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kentucky, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Streamflow, Suspended sediments, Water level, Water temperature.

Water resources data for the 1984 water year for Kentucky consist of records of stage, discharge, and water quality of streams: stage and contents of lakes; and water levels and water quality of wells and springs. This report contains discharge records from 99 gaging stations; stage and contents for 4 lakes; suspended-sediment data for 26 stations (8 daily); daily temperature records for 13 stations; daily specific conductance for 9 stations; groundwater levels for 22 continuous-record wells and 102 partial-records wells; water quality data from 16 surface water stations sampled at regular intervals; and miscellaneous temperature and specific conductance data from 82 gaging stations. Also included are data for 85 partial-record crest-stage sites. Data collected at various miscellaneous sites are also published. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky. (USGS)
W90-06388

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1986.
Geological Survey, Lawrence, KS. Water Resources Div.
C. O. Geiger, D. L. Lacock, J. E. Putnam, C. E. Merry, and D. R. Schneider.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-150651/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report KS-86-1 (WRD/HD-88/205), 1987. 482p. Prepared in cooperation

with the State of Kansas and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kansas, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Kansas consist of records of stage, discharge, and water quality of streams; elevation, contents, and water quality of lakes or reservoirs; and water levels and water quality of groundwater wells. This report contains records for water discharge at 139 gaging stations; elevation and contents at 24 lakes or reservoirs; water quality at 31 gaging stations; and water levels at 1,490 observation wells and water quality at 221 wells. Also included are data for 88 high-flow, 10 low-flow, and 2 flood hydrograph partial-record stations; and 2 chemical-quality of precipitation stations. Miscellaneous field water-quality data were collected at 101 measuring sites, and miscellaneous water-quality data were collected at 14 sampling sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Kansas. (See also W90-06387) (USGS)
W90-06389

WATER RESOURCES DATA FOR KANSAS, WATER YEAR 1988.
Geological Survey, Lawrence, KS. Water Resources Div.
C. O. Geiger, D. L. Lacock, C. E. Merry, and D. R. Schneider.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-140328. Price codes: A22 in paper copy, A03 in microfiche. USGS Water-Data Report KS-88-1 (WRD/HD-89/281), 1989. 490p. Prepared in cooperation with the State of Kansas and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kansas, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Kansas consist of records of stage, discharge, and water quality of streams; elevation, contents, and water quality of lakes or reservoirs; and water levels and water quality of groundwater wells. This report contains records for water discharge at 140 gaging stations; elevation and contents at 24 lakes or reservoirs; water quality at 26 gaging stations; and water levels at 1,590 observation wells and water quality at 221 wells. Also included are data for 87 high-flow, 10 low-flow, and 1 flood hydrograph partial-record station; and 2 chemical-quality of precipitation stations. Miscellaneous field water-quality data were collected at 101 measuring sites, and miscellaneous water-quality data were collected at 14 sampling sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Kansas. (See also W90-06389) (USGS)
W90-06390

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1986.
Geological Survey, Louisville, KY. Water Resources Div.
S. G. Toms, C. J. Sholar, and D. D. Zettwoch.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-137492. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report KY-86-1 (WRD/HD-87/243), 1987. 380p. Prepared in cooperation with the State of Kentucky and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kentucky, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Streamflow, Suspended sediments, Water level, Water temperature, Wells.

Water resources data for the 1986 water year for Kentucky consist of records of stage, discharge, and water quality of streams; stage and water levels of wells. This report contains discharge records from 103 gaging stations; suspended-sediment data for 26 stations (11 daily); daily temperature records for 14 stations; daily specific conductance for 12 stations; groundwater levels for 9 continuous-record wells and 102 partial-record wells; water-quality data from 26 surface-water stations sampled at regular intervals; and miscellaneous temperature and specific conductance data from 81 gaging stations. Also included are 77 partial-record crest-stage sites. Data collected at various miscellaneous sites are also published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky. (See also W90-06388) (USGS)
W90-06391

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1987.
Geological Survey, Louisville, KY. Water Resources Div.
S. G. Toms, C. J. Sholar, and D. D. Zettwoch.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-249321/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report KY-87-1 (WRD/HD-88/242), 1987. 356p. Prepared in cooperation with the State of Kentucky and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kentucky, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Streamflow, Suspended sediments, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Kentucky consist of records of stage, discharge, and water quality of streams; stage and water levels of wells. This report contains discharge records from 102 gaging stations; suspended-sediment data for 21 stations (12 daily); daily temperature records for 9 stations; daily specific conductance for 6 stations; groundwater levels for 22 continuous-record wells and 119 partial-record wells; water-quality data from 24 surface-water stations sampled at regular intervals; and miscellaneous temperature and specific conductance data from 79 gaging stations. Also included are 31 partial-record crest-stage and 80 low-flow partial-record and miscellaneous sites. Data collected at various miscellaneous sites are also published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky. (See also W90-06391) (USGS)
W90-06392

WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1988.
Geological Survey, Louisville, KY. Water Resources Div.
R. Garcia, C. J. Sholar, and S. G. Toms.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-232425/AS. Price codes: A25 in paper copy, A01 in microfiche. USGS Water-Data Report KY-88-1 (WRD/HD-89/257), 1988. 569p. Prepared in cooperation with the State of Kentucky and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Kentucky, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Streamflow, Suspended sediments, Water level, Water temperature, Wells.

Water resources data for the 1988 water year for Kentucky consist of records of stage, discharge, and water quality of streams; stage and water levels of wells. This report contains discharge records from 107 gaging stations; suspended-sediment data for 21 stations (12 daily); daily temperature records for 15 stations; daily specific conductance for 12 stations; groundwater levels for 22 continuous-record wells and 117 partial-record wells; water-quality data from 50 surface-water stations sampled at regular intervals; and miscellaneous temperature and specific conductance data from 106 gaging stations. Also included are 21 partial-record crest-stage and 144 low-flow partial record and miscellaneous sites. Data collected at various miscellaneous sites are also published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky. (See also W90-06392) (USGS)
W90-06393

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1986.
Geological Survey, Baton Rouge, LA. Water Resources Div.
D. D. Carlson, L. J. Dantin, C. R. Garrison, and C. G. Stuart.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-156799/AS. Price codes: A24 in paper copy, A01 in microfiche. USGS Water-Data Report LA-86-1 (WRD/HD-87/267), 1986. 547p. Prepared in cooperation with the State of Louisiana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Louisiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Louisiana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains records for water discharge at 70 gaging stations; stage only for 17 gaging stations and 11 lakes; water quality for 56 surface-water stations (including 24 gaging stations), 6 lakes, and 113 wells; and water levels for 398 observation wells. Also included are data for 136 crest-stage and flood-profile partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Louisiana. (USGS)
W90-06394

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1987.
Geological Survey, Baton Rouge, LA. Water Resources Div.
D. D. Carlson, L. J. Dantin, C. R. Garrison, and C. G. Stuart.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-174395/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report LA-87-1 (WRD/HD-89/205), 1988. 445p. Prepared in cooperation with the State of Louisiana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Louisiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Louisiana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains records for water discharge at 63 gaging stations; stage only for 19 gaging stations and 7 lakes; water quality for 48 surface-water stations (including 19 gaging stations), 6 lakes, and 77 wells; and water levels for 346 observation wells. Also included are data for 103 crest-stage and flood-profile partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program, and are published as miscellaneous measure-

ments. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Louisiana. (See also W90-06394) (USGS)
W90-06395

WATER RESOURCES DATA FOR LOUISIANA, WATER YEAR 1988.
Geological Survey, Baton Rouge, LA. Water Resources Div.
G. J. Arcement, L. J. Dantin, C. R. Garrison, and C. G. Stuart.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-230601/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report LA-88-1 (WRD/HD-89/262), 1989. 413p. Prepared in cooperation with the State of Louisiana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Louisiana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Louisiana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This report contains records for water discharge at 61 gaging stations; stage only for 19 gaging stations and 7 lakes; water quality for 39 surface-water stations (including 15 gaging stations), and 118 wells; and water levels for 215 observation wells. Also included are data for 103 crest-stage and flood-profile partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Louisiana. (See also W90-06395) (USGS)
W90-06396

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1985.
Geological Survey, Augusta, ME. Water Resources Div.
W. P. Bartlett, W. B. Higgins, and W. J. Nichols.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-181896/AS. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report ME-85-1 (WRD/HD-88/210), 1987. 158p. Prepared in cooperation with the State of Maine and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Maine, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Maine consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 48 gaging stations; stage only for 2 gaging stations; contents for 17 lakes and reservoirs; water quality for 11 gaging stations and 6 groundwater wells; and water levels for 17 groundwater wells. Additional water data were collected at other sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies. (USGS)
W90-06397

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1986.
Geological Survey, Augusta, ME. Water Resources Div.
W. P. Bartlett, W. B. Higgins, and W. J. Nichols.
Available from the National Technical Information Service, Springfield, VA 22161. USGS Water-Data Report ME-86-1 (WRD/HD-88/251), 1988. 159p. Prepared in cooperation with the State of Maine and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Maine, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Maine consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 48 gaging stations; stage only for 2 gaging stations; contents for 17 lakes and reservoirs; water quality for 11 gaging stations and 5 groundwater wells; and water levels for 19 groundwater wells. Additional water data were collected at other sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies. (See also W90-06397) (USGS)
W90-06398

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1987.
Geological Survey, Augusta, ME. Water Resources Div.
W. P. Bartlett, W. B. Higgins, and W. J. Nichols.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-190466/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report ME-87-1 (WRD/HD-89/217), 1989. 173p. Prepared in cooperation with the State of Maine and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Maine, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Maine consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 49 gaging stations; stage only for 2 gaging stations; contents for 17 lakes and reservoirs; water quality for 10 gaging stations and 3 groundwater wells; and water levels for 24 groundwater wells. Additional water data were collected at other sites, not part of the systematic data collection program, and are published as miscellaneous measurements. (See also W90-06398) (USGS)
W90-06399

WATER RESOURCES DATA FOR MAINE, WATER YEAR 1988.
Geological Survey, Augusta, ME. Water Resources Div.
W. P. Bartlett, W. B. Higgins, and W. J. Nichols.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-113390/AS. Price codes: A09 in paper copy, A02 in microfiche. USGS Water-Data Report ME-88-1 (WRD/HD-89/277), 1989. 183p. Prepared in cooperation with the State of Maine and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Maine, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Maine consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 51 gaging stations; stage only for 2 gaging stations; contents for 17 lakes and reservoirs; water quality for 12 gaging stations; and water levels for 31 groundwater wells. Additional water data were collected at other sites, not part of the systematic data collection program, and are published as miscellaneous measurements. (See also W90-06399) (USGS)
W90-06400

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1986.
Geological Survey, Towson, MD. Water Resources Div.
R. W. James, R. H. Simmons, and B. F. Strain.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-136783/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report MD-DE-86-1 (WRD/HD-87/227), 1986. 316p. Prepared in cooperation with the States of Maryland and Delaware and with other agencies.

Descriptors: *Data collections, *Delaware, *District of Columbia, *Groundwater, *Hydrologic data, *Maryland, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Maryland and Delaware consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 96 gaging stations; stage and contents at 1 reservoir; water quality at 23 gaging stations and 228 wells; and water levels at 24 observation wells. Also included are data for 12 crest-stage, 11 low-flow, and 6 tidal crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Maryland and Delaware. (USGS)
W90-06401

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1987.
Geological Survey, Towson, MD. Water Resources Div.
R. W. James, R. J. Simmons, and B. F. Strain.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-246905/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report MD-DE-87-1 (WRD/HD-88/244), 1987. 470p. Prepared in cooperation with the States of Maryland and Delaware and with other agencies.

Descriptors: *Data collections, *Delaware, *District of Columbia, *Groundwater, *Hydrologic data, *Maryland, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Maryland and Delaware consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 98 gaging stations; stage and contents at 1 reservoir; water quality at 20 gaging stations and 147 wells; and water levels at 149 observation wells. Also included are data for 3 crest-stage, 10 low-flow, and 6 tidal crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State,

local, and Federal agencies in Maryland and Delaware. (See also W90-06401) (USGS)
W90-06402

WATER RESOURCES DATA FOR MARYLAND AND DELAWARE, WATER YEAR 1988.
Geological Survey, Towson, MD. Water Resources Div.
R. W. James, R. H. Simmons, B. F. Strain, and M. J. Smigaj.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194542. Price codes: A99 in paper copy, A01 in microfiche. USGS Water-Data Report MD-DE-88-1 (WRD/HD-88/232), 1988. 590p. Prepared in cooperation with the States of Maryland and Delaware and with other agencies.

Descriptors: *Data collections, *Delaware, *District of Columbia, *Groundwater, *Hydrologic data, *Maryland, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Maryland and Delaware consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 100 gaging stations; stage and contents at 1 reservoir; water quality at 23 gaging stations and 229 wells; and water levels at 204 observation wells. Also included are data for 3 crest-stage, 9 low-flow, and 6 tidal crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Maryland and Delaware. (See also W90-06402) (USGS)
W90-06403

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1985.
Geological Survey, Boston, MA. Water Resources Div.
R. A. Gadoury, D. J. Kent, K. G. Ries, and H. L. White.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-137567. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report MA-RI-85-1 (WRD/HD-87/262), 1987. 235p. Prepared in cooperation with the States of Massachusetts and Rhode Island and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Massachusetts, *Rhode Island, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Massachusetts and Rhode Island consist of records of stage, discharge, and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 97 gaging stations, monthend contents for 31 lakes and reservoirs, water quality for 9 gaging stations, and water levels for 104 observation wells. Also included are data for one crest-stage partial-record station. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. A few pertinent stations (not included above) in bordering states are also included in this report. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Massachusetts and Rhode Island. (USGS)
W90-06404

WATER RESOURCES DATA FOR MASSACHUSETTS AND RHODE ISLAND, WATER YEAR 1986.
Geological Survey, Boston, MA. Water Resources Div.
R. A. Gadoury, D. J. Kent, K. G. Ries, and H. L. White.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194567/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report MA-RI-86-1 (WRD/HD-88/282), 1988. 251p. Prepared in cooperation with the States of Massachusetts and Rhode Island and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Massachusetts, *Rhode Island, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Massachusetts and Rhode Island consist of records of stage, discharge, and water quality of streams; contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 97 gaging stations, monthend contents for 30 lakes and reservoirs, water quality for 9 gaging stations, and water levels for 111 observation wells. Also included are data for one crest-stage partial-record station. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. A few pertinent stations in bordering states are also included in this report. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Massachusetts and Rhode Island. (See also W90-06404) (USGS)
W90-06405

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1986.
Geological Survey, Lansing, MI. Water Resources Div.
J. B. Miller, J. C. Failing, and W. W. Larson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-107578/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report MI-86-1 (WRD/HD-87/254), 1987. 353p. Prepared in cooperation with the State of Michigan and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Michigan, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Michigan consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water temperature of groundwater. This report contains discharge records for 136 gaging stations; stage only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water-quality records for 56 gaging stations; water-level records for 53 observation wells; and water-temperature records for 6 observation wells. Also included are 52 crest-stage partial-record stations and 33 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program. Miscellaneous data were collected at 58 measuring sites and 38 water-quality sampling sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Michigan. (USGS)
W90-06406

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1987.
Geological Survey, Lansing, MI. Water Resources Div.
S. P. Blumer, J. C. Failing, W. W. Larson, C. R. Whited, and R. L. LeuVoy.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-231287/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report MI-87-1 (WRD/HD-88/231), 1988. 281p. Prepared in cooperation with the State of Michigan and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Michigan, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Michigan consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water temperature of groundwater. This report contains discharge records for 135 streamflow-gaging stations; stage only records for 15 lake-gaging stations; stage and contents for 5 lakes and reservoirs; water-quality records for 24 streamflow-gaging stations; water-level records for 52 observation wells; and water-temperature records for 6 observation wells. Also included are 52 crest-stage partial-record stations and 8 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program. Miscellaneous data were collected at 100 measuring sites and 23 water-quality sampling sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Michigan. (See also W90-06406) (USGS)
W90-06407

WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1988.
Geological Survey, Lansing, MI. Water Resources Div.
S. P. Blumer, J. C. Failing, W. W. Larson, C. R. Whited, and R. L. LeuVoy.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203517. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report MI-88-1 (WRD/HD-89/235), 1989. 296p. Prepared in cooperation with the State of Michigan and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Michigan, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Michigan consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water temperature of groundwater. This report contains discharge records for 138 streamflow-gaging stations; stage only records for 15 lake-gaging stations; stage and contents for 5 lakes and reservoirs; water-quality records for 20 streamflow-gaging stations; water-level records for 51 observation wells. Also included are 52 crest-stage partial-record stations and 8 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program. Miscellaneous data were collected at 180 measuring sites and 10 water-quality sampling sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Michigan. (See also W90-06407) (USGS)
W90-06408

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1984. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E.

Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172318/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report MN-84-1 (WRD/HD-87/210), 1986. 181p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 50 gaging stations; stage-only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water quality for 16 gaging stations, 10 partial-record stations, and 29 wells; and water levels for 39 observation wells. Also included are 41 high-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data together with the data in Volume 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (USGS)
W90-06409

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1985. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-221171. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report MN-85-1 (WRD/HD-88/208), 1987. 191p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 46 gaging stations; stage-only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water quality for 8 gaging stations, 7 partial-record stations, 10 lake stations, and 12 wells; and water levels for 26 observation wells. Also included are 38 high-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data together with the data in Volume 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-06409 and W90-06411) (USGS)
W90-06410

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1985. VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-221650/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report MN-85-2 (WRD/HD-88/209), 1987. 341p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 59 gaging stations; stage and contents for 8 lakes and reservoirs; water quality for 14 stream stations, 2 partial-record stations, 1 lake station, 1 precipitation station, and 151 wells; and water levels for 152 observation wells. Also included are 96 high-flow partial-record stations and 99 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program and are published as miscellaneous measurements. These data, together with the data in Volume 1, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-06410) (USGS)
W90-06411

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1986. VOLUME 1. GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-165880/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report MN-86-1 (WRD/HD-88/274), 1988. 184p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 52 gaging stations; stage-only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water quality of 10 stream stations and 15 partial-record lake stations; and water levels for 16 observation wells. Also included are 35 high-flow partial-record stations and 23 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data together with the data in Volume 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-06410 and W90-06413) (USGS)
W90-06412

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1986. VOLUME 2. UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-165898/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report MN-86-2 (WRD/HD-88/275), 1988. 295p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 53 gaging stations; stage and contents for 8 lakes and reservoirs; water quality for 14 stream stations, 8 partial-record stations, 1 lake station, 1 precipitation station, and 87 wells; and water levels for 136 observation wells. Also included are 78 high-flow partial-record stations and 1 low-flow partial-record station. Additional water data were collected at various sites, not part of the systematic data collection program and are published as miscellaneous measurements or low-flow investigations. These data, together with the data in Volume 1, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-06412) (USGS)
W90-06413

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1985.
Geological Survey, Jackson, MS. Water Resources Div.
E. J. Tharpe, M. L. Plunkett, F. Morris, and W. T. Oakley.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-209003/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report MS-85-1 (WRD/HD-87/217), 1987. 456p. Prepared in cooperation with the State of Mississippi and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Mississippi, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Mississippi consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains records of water discharge at 71 gaging stations; stage records for 18 of these gaging stations; stage only at 5 gaging stations; water quality for 13 stations, 2 precipitation quality stations, and 263 wells; and water levels for 629 observation wells. Also included are peak-discharge data for 58 crest-stage partial-record stations and water quality data at 106 partial-record or miscellaneous sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Mississippi. (USGS)
W90-06414

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1986.
Geological Survey, Jackson, MS. Water Resources Div.
E. J. Tharpe, M. L. Plunkett, F. Morris, and W. T. Oakley.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-137575/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report MS-86-1 (WRD/HD-87/269), 1987. 396p. Prepared in cooperation

with the State of Mississippi and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Mississippi, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Mississippi consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains records of water discharge at 71 gaging stations; stage records for 18 of these gaging stations; stage only at 5 gaging stations; water quality for 12 stations, 3 precipitation quality stations, and 32 wells; and water levels for 609 observation wells. Also included are peak-discharge data for 56 crest-stage partial-record stations, discharge data at 97 low-flow partial-record stations, and water quality data at 3 partial-record or miscellaneous sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Mississippi. (See also W90-06414) (USGS)
W90-06415

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1987.
Geological Survey, Jackson, MS. Water Resources Div.
E. J. Tharpe, M. L. Plunkett, F. Morris, and W. T. Oakley.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-228670/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report MS-87-1 (WRD/HD-88/273), 1988. 408p. Prepared in cooperation with the State of Mississippi and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Mississippi, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Mississippi consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains records of water discharge at 78 gaging stations; stage records for 18 of these gaging stations; stage only at 5 gaging stations; water quality for 11 stations, 3 precipitation quality stations, and 120 wells; and water levels for 498 observation wells. Also included are peak-discharge data for 56 crest-stage partial-record stations, discharge data at 263 low-flow partial-record stations, and water quality data at 2 partial-record or miscellaneous sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Mississippi. (See also W90-06415) (USGS)
W90-06416

WATER RESOURCES DATA FOR MISSISSIPPI, WATER YEAR 1988.
Geological Survey, Jackson, MS. Water Resources Div.
E. J. Tharpe, M. L. Plunkett, F. Morris, and W. T. Oakley.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-203509/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report MS-88-1 (WRD/HD-89/227), 1989. 428p. Prepared in cooperation with the State of Mississippi and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Mississippi, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Mississippi consist of records of stage, discharge, and water quality of streams; stage and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains records of water discharge at 70 gaging stations; stage records for 19 of these gaging stations; stage only at 6 gaging stations; water quality for 11 streamflow gaging stations, 2 ungaged stream sites, 3 precipitation quality stations, and 205 wells; and water levels for 498 observation wells. Also included are peak-discharge data for 55 crest-stage partial-record stations, discharge data at 5 flood hydrograph partial-record stations and 158 low-flow partial-record stations, and water quality data at 12 partial-record or miscellaneous sites and 26 short-term study sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Mississippi. (See also W90-06416) (USGS)
W90-06417

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1986.
Geological Survey, Rolla, MO. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-117023/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report MO-86-1 (WRD/HD-87/251), 1987. 319p. Prepared in cooperation with the State of Missouri and other agencies.

Descriptors: *Data collections, *Hydrologic data, *Missouri, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Missouri consist of records of stage, discharge, and water quality of lakes and reservoirs. The report contains records for water discharge at 107 gaging stations; stage and contents at 10 lakes and reservoirs; and water quality at 67 sampling stations (including 2 lakes); and data for 20 crest-stage stations. (USGS)
W90-06418

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1987.
Geological Survey, Rolla, MO. Water Resources Div.
L. A. Waite, J. V. Davis, H. L. Reed, D. O. Hatten, and T. J. Perkins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-121016/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report MO-87-1 (WRD/HD-88/266), 1988. 295p. Prepared in cooperation with the State of Missouri and other agencies.

Descriptors: *Data collections, *Hydrologic data, *Missouri, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Missouri consist of records of stage, discharge, and water quality of lakes and reservoirs. The report contains records for water discharge at 105 gaging stations; stage and contents at 10 lakes and reservoirs; water quality at 60 sampling stations (including 2 lakes); and data for 18 crest-stage stations. (See also W90-06418) (USGS)
W90-06419

WATER RESOURCES DATA FOR MISSOURI, WATER YEAR 1988.
Geological Survey, Rolla, MO. Water Resources Div.
L. A. Waite, J. V. Davis, H. L. Reed, D. O. Hatten, and T. J. Perkins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-221089/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report MO-88-1 (WRD/HD-89/260), 1989. 289p. Prepared in cooperation with the State of Missouri and other agencies.

Descriptors: *Data collections, *Hydrologic data, *Missouri, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Missouri consist of records of stage, discharge, and water quality of lakes and reservoirs. This report contains records for water discharge at 108 gaging stations; stage and contents at 10 lakes and reservoirs; water quality at 51 sampling stations (including 2 lakes); and data for 18 crest-stage stations. (See also W90-06419) (USGS)
W90-06420

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1986. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
R. R. Shields, J. R. Knapton, M. K. White, T. M. Brosten, and J. H. Lambing.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-182944/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report MT-86-1 (WRD/HD-87/271), 1987. 437p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Montana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. Volume 1 contains discharge records for 191 gaging stations; stage only records for 1 lake station; stage/contents for 5 lakes and reservoirs; water quality for 60 stations; water levels for 194 observation wells. Also included are 132 crest-stage partial-record stations and 33 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. Specific conductance determinations are also published for discharge measurements made during the year. (See also W90-06422) (USGS)
W90-06421

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1986. VOLUME 2. COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
R. R. Shields, J. R. Knapton, M. K. White, T. M. Brosten, and J. H. Lambing.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-227492/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report MT-86-2 (WRD/HD-87/231), 1987. 170p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Montana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites,

Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. Volume 2 contains discharge records for 60 gaging stations; stage/contents for 3 lakes and reservoirs; water quality for 23 stations, 3 lakes; water levels for 9 observation wells and 3 long-term observation wells equipped with continuous recorders. Also included are 24 crest-stage partial-record stations and 20 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (See also W90-06421) (USGS)
W90-06422

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1987. VOLUME 1. HUDSON BAY AND MISSOURI RIVER BASINS.
Geological Survey, Helena, MT. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-117626/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report MT-87-1 (WRD/HD-88/276), 1988. 432p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Montana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. Volume 1 contains discharge records for 186 gaging stations; stage/contents for 6 lakes and reservoirs; water quality for 53 stations; water levels for 250 observation wells. Also included are 131 crest-stage partial-record stations and 33 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. Specific conductance determinations are also published for discharge measurements made during the year. (See also W90-06421 and W90-06424) (USGS)
W90-06423

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1987. VOLUME 2. COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-242409/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report MT-87-2 (WRD/HD-88/230), 1988. 176p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Montana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. Volume 2 contains discharge records for 60 gaging stations; stage/contents for 3 lakes and reservoirs; water quality for 22 stations, 3 lakes; water levels for 32 observation wells and 3 long-term observation wells equipped with continuous recorders. Also included are 23 crest-stage partial-record stations and 20 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (See also W90-06423) (USGS)
W90-06424

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1988.
Geological Survey, Helena, MT. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-207583/AS. Price codes: A23 in paper copy, A01 in microfiche. USGS Water-Data Report MT-88-1 (WRD/HD-89/223), 1989. 511p. Prepared in cooperation with the State of Montana and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Montana, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 238 gaging stations; stage/contents for 9 lakes and reservoirs; water quality for 91 stations, 3 lakes; water levels for 254 observation wells and 5 long-term observation wells equipped with continuous recorders. Also included are 53 smaller reservoirs. Additional water year 1988 data collected at crest-stage gage and miscellaneous measurement sites were collected but are not published in this report. These data are stored within the district office files in Helena and are available on request. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (See also W90-06423) (USGS)
W90-06425

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1985.
Geological Survey, Lincoln, NE. Water Resources Div.
G. B. Engel, R. A. Engberg, and M. J. Ellis.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-172532/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report NE-85-1 (WRD/HD-87/212), 1986. 340p. Prepared in cooperation with the State of Nebraska and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nebraska, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Nebraska consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality in wells. This report contains discharge records for 159 streamflow gaging stations, 11 partial-record or miscellaneous streamflow gaging stations, and 5 crest-stage, partial-record streamflow stations; stage and content records for 10 lakes and reservoirs; water quality records for 43 streamflow stations, 8 ungaged streamsites, and 131 wells; and water level records for 57 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nebraska. (USGS)
W90-06426

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1986.
Geological Survey, Lincoln, NE. Water Resources Div.
G. B. Engel, C. G. Hoy, and M. J. Ellis.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-144654/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report NE-86-1 (WRD/HD-88/204), 1987. 371p. Prepared in cooperation with the State of Nebraska and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nebraska, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Nebraska consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality in wells. This report contains discharge records for 160 streamflow gaging stations, 7 partial-record or miscellaneous streamflow stations, and 5 crest-stage, partial-record streamflow stations; stage and contents records for 11 lakes and reservoirs; water quality records for 43 streamflow stations, 8 ungaged streamsites, and 144 wells; and water level records for 56 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nebraska. (See also W90-06426) (USGS)
W90-06427

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1987.
Geological Survey, Lincoln, NE. Water Resources Div.
J. A. Boohar, C. G. Hoy, and M. J. Ellis.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-141352/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report NE-87-1 (WRD/HD-89/210), 1988. 391p. Prepared in cooperation with the State of Nebraska and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nebraska, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Nebraska consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality in wells. This report contains discharge records for 158 streamflow gaging stations, 7 partial-record or miscellaneous streamflow stations, and 5 crest-stage, partial-record streamflow stations; stage and contents records for 11 lakes and reservoirs; water quality records for 35 streamflow stations, 8 ungaged streamsites, and 144 wells; and water level records for 56 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nebraska. (See also W90-06427) (USGS)
W90-06428

WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1988.
Geological Survey, Lincoln, NE. Water Resources Div.
J. A. Boohar, C. G. Hoy, and M. J. Ellis.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-233407/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report NE-88-1 (WRD/HD-89/273), 1989. 391p. Prepared in cooperation with the State of Nebraska and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nebraska, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Nebraska consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality in wells. This report contains discharge records for 158 streamflow gaging stations, 10 partial-record or miscellaneous streamflow stations, and 5 crest-stage, partial-record streamflow stations; stage and contents records for 11 lakes and reservoirs; water quality records for 37 streamflow stations, 6 ungaged streamsites, and 84 wells; and water level records for 56 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nebraska. (See also W90-06428) (USGS)
W90-06429

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1985.
Geological Survey, Carson City, NV. Water Resources Div.
H. R. Frisbie, R. J. LaCamera, M. M. Riek, and D. B. Wood.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-124267/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report NV-85-1 (WRD/HD-87/234), 1987. 255p. Prepared in cooperation with the State of Nevada and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nevada, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for Nevada for the 1984 water year comprise the following records: (1) Water discharge for 89 gaging stations on streams, canals, and drains; (2) Discharge data for 43 peak-flow stations, 2 low-flow stations on streams, and 41 springs; (3) Stage and contents for 14 lakes and reservoirs; (4) Water levels for 298 observation wells; (5) Water quality data for 23 stream, canal, and drain sites, 3 lake and reservoir sites, and 5 wells; and (6) Precipitation totals for 10 stations. Additional water data, collected at various sites that are not part of the systematic data-collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nevada. (USGS)
W90-06430

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1986.
Geological Survey, Carson City, NV. Water Resources Div.
A. Pupacko, R. J. LaCamera, M. M. Riek, and D. B. Wood.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-125876/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report NV-86-1 (WRD/HD-88/245), 1987. 263p. Prepared in cooperation with the state of Nevada and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nevada, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for Nevada for the 1986 water year comprise the following records: (1) Water discharge for 91 gaging stations on streams, canals, and drains; (2) Discharge data for 78 peak-flow stations, 2 low-flow stations on streams, and 39 springs; (3) Stage and contents for 15 lakes and reservoirs; (4) Water levels for 354 observation wells; (5) Water quality data for 18 stream, canal, and drain sites, and 5 wells; and (6) Precipitation totals for 16 stations. Additional water data, collected at various sites that are not part of the systematic data-collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nevada. (See also W90-06430) (USGS)
W90-06431

WATER RESOURCES DATA FOR NEVADA, WATER YEAR 1987.
Geological Survey, Carson City, NV. Water Resources Div.
A. Pupacko, R. J. LaCamera, M. M. Riek, and J. R. Swartwood.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-180392/AS. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report NV-87-1 (WRD/HD-89/219), 1989. 250p. Prepared in cooperation with several Federal, State and local agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Nevada, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for Nevada for the 1987 water year comprise the following records: (1) Water discharge for 86 gaging stations on streams, canals, and drains; (2) Discharge data for 144 peak-flow stations and miscellaneous sites, and 35 springs; (3) Stage and contents for 14 lakes and reservoirs; (4) Water levels for 304 observation wells; (5) Water quality data for 29 stream, canal, and drain sites, and 5 wells; and (6) Precipitation totals for 12 stations. Additional water data, collected at various sites that are not part of the systematic data-collection program, are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nevada. (See also W90-06431) (USGS)
W90-06432

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1985.
Geological Survey, Boston, MA. Water Resources Div.
F. E. Blackey, J. E. Cotton, and K. W. Toppin.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-223020/AS. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report NH-VT-85-1 (WRD/HD-87/221), 1987. 139p. Prepared in cooperation with the State of New Hampshire and Vermont and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Hampshire, *Surface water, *Vermont, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for New Hampshire and Vermont consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 74 gaging stations, stage records for 4 lakes, month-end contents for 24 lakes and reservoirs, water quality data for 3 gaging stations, and water levels for 30 observation wells. Also included are data for 4 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements Locations of gaging stations, partial-record stations, and observation wells are shown. A few pertinent stations (not included above) in bordering States and Province of Quebec are also included. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and by the cooperating State and Federal agencies in New Hampshire and Vermont. (USGS)
W90-06433

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1986.
Geological Survey, Boston, MA. Water Resources Div.
F. E. Blackey, J. E. Cotton, and J. C. Denner.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-231295/AS. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report NH-VT-86-1 (WRD/HD-88/229), 1988. 140p. Prepared in cooperation with the State of New Hampshire and Vermont and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Hampshire, *Surface water, *Vermont, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New Hampshire and Vermont consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 70 gaging stations, stage records for 4 lakes, month-end contents for 23 lakes and reservoirs, water quality data for 7 gaging stations, and water levels for 30 observation wells. Also included are data for 4 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements Locations of gaging stations, partial-record stations, and observation wells are shown. A few pertinent stations (not included above) in bordering States and Province of Quebec are also included. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and by the cooperating State and Federal agencies in New Hampshire and Vermont. (See also W90-06433) (USGS)
W90-06434

WATER RESOURCES DATA FOR NEW HAMPSHIRE AND VERMONT, WATER YEAR 1987.
Geological Survey, Boston, MA. Water Resources Div.
F. E. Blackey, J. E. Cotton, and S. M. Flanagan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-115528/AS. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report NH-VT-87-1 (WRD/HD-88/279), 1989. 142p. Prepared in cooperation with the State of New Hampshire and Vermont and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Hampshire, *Surface water, *Vermont, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New Hampshire and Vermont consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 72 gaging stations, stage records for 4 lakes, month-end contents for 23 lakes and reservoirs, water quality data for 3 gaging stations, and water levels for 29 observation wells. Also included are data for 7 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements Locations of gaging stations, partial-record stations, and observation wells are shown. A few pertinent stations (not included above) in bordering States and Province of Quebec are also included. These data represent that portion of the National Water Data System operated by the U.S. Geological Survey and by the cooperating State and Federal agencies in New Hampshire and Vermont. (See also W90-06434) (USGS)
W90-06435

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1986. VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-121710/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-86-1 (WRD/HD-87/260), 1987. 335p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Jersey, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 77 gaging stations; tide summaries for 1 station; stage and contents for 15 lakes and reservoirs; water quality for 60 surface water sites and 150 wells; and water levels for 39 observation wells. Also included are data for 41 crest-stage partial-record stations, 12 tidal crest-stage gages, and 49 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-06437) (USGS)
W90-06436

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1986. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-121728/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-86-2 (WRD/HD-87/261), 1987. 197p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Jersey, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 23 gaging stations; tide summaries for 3 stations; stage and contents for 18 lakes and reservoirs; water quality for 30 surface water sites and 79 wells; and water levels for 23 observation wells. Also included are data for 27 crest-stage partial-record stations, 2 tidal crest-stage gages, and 9 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-06436) (USGS)
W90-06437

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1987. VOLUME 1: ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-117618/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-87-1 (WRD/HD-88/271), 1988. 347p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Jersey, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 77 gaging stations; tide summaries for 1 station; stage and contents for 15 lakes and reservoirs; water quality for 62 surface water sites and 160 wells; and water levels for 39 observation wells. Also included are data for 40 crest-stage partial-record stations, 12 tidal crest-stage gages, and 49 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-06436 and W90-06439) (USGS)
W90-06438

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1987. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-120463/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-87-2 (WRD/HD-88/272), 1988. 199p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Jersey, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 23 gaging stations; tide summaries for 3 stations; stage and contents for 18 lakes and reservoirs; water quality for 32 surface water sites and 114 wells; and water levels for 24 observation wells. Also included are data for 27 crest-stage partial-record stations, 2 tidal crest-stage gages, and 19 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-06438) (USGS)
W90-06439

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1988, VOLUME 1. ATLANTIC SLOPE BASINS, HUDSON RIVER TO CAPE MAY.
Geological Survey, Towson, MD. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-233613/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-88-1 (WRD/HD-89/274), 1989. 359p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Jersey, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 77 gaging stations; tide summaries for 1 station; stage and contents for 15 lakes and reservoirs; water quality for 61 surface water sites and 141 wells; and water levels for 68 observation wells. Also included are data for 37 crest-stage partial-record stations, 12 tidal crest-stage gages, and 43 low-flow partial-record stations. Additional water data were collected at 60 sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-06438 and W90-06441) (USGS)
W90-06440

WATER RESOURCES DATA FOR NEW JERSEY, WATER YEAR 1988. VOLUME 2: DELAWARE RIVER BASIN AND TRIBUTARIES TO DELAWARE BAY.
Geological Survey, Towson, MD. Water Resources Div.
W. R. Bauersfeld, E. W. Moshinsky, E. A. Pustay, and W. D. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-233621/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report NJ-88-2 (WRD/HD-89/275), 1989. 217p. Prepared in cooperation with the New Jersey Department of Environmental Protection and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Jersey, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for New Jersey consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater. This volume contains discharge records for 24 gaging stations; tide summaries for 3 stations; stage and contents for 18 lakes and reservoirs; water quality for 30 surface water sites and 81 wells; and water levels for 53 observation wells. Also included are data for 27 crest-stage partial-record stations, 2 tidal crest-stage gages and 19 low-flow partial-record stations. Additional water data were collected at 26 sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Jersey. (See also W90-06440) (USGS)
W90-06441

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1986.
Geological Survey, Albuquerque, NM. Water Resources Div.

L. V. Beal, and R. L. Gold.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-148531/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report NM-86-1 (WRD/HD-87/273), 1987. 454p. Prepared in cooperation with the State of New Mexico and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Mexico, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New Mexico consist of records of discharge and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report contains discharge records for 166 gaging stations; stage and contents for 24 lakes and reservoirs; water quality for 64 gaging stations and 168 wells; and water levels at 111 observation wells. Also included are 135 crest-stage partial-record stations. Additional water data were collected at various sites, not involved in the systematic data-collection program, and are published as miscellaneous measurements. Also, one seepage investigation was published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Mexico. (USGS)
W90-06442

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1987.
Geological Survey, Albuquerque, NM. Water Resources Div.
L. V. Beal, and R. L. Gold.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-114359/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report NM-87-1 (WRD/HD-88/261), 1988. 450p. Prepared in cooperation with the State of New Mexico and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Mexico, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New Mexico consist of records of discharge and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report contains discharge records for 165 gaging stations; stage and contents for 25 lakes and reservoirs; water quality for 67 gaging stations and 180 wells; and water levels at 100 observation wells. Also included are 108 crest-stage partial-record stations. Additional water data were collected at various sites, not involved in the systematic data-collection program, and are published as miscellaneous measurements. Also, one seepage investigation was published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Mexico. (See also W90-06442) (USGS)
W90-06443

WATER RESOURCES DATA FOR NEW MEXICO WATER YEAR 1988.
Geological Survey, Albuquerque, NM. Water Resources Div.
L. V. Beal, and J. P. Borland.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-214712/AS. Price codes: A22 in paper copy, A01 in microfiche. USGS Water-Data Report NM-88-1 (WRD/HD-89/261), 1989. 450p. Prepared in cooperation with the State of New Mexico and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New Mexico, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for New Mexico consist of records of discharge and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report contains discharge records for 165 gaging stations; stage and contents for 26 lakes and reservoirs; water quality for 64 gaging stations and 76 wells; and water levels at 105 observation wells. Also included are 108 crest-stage partial-record stations. Additional water data were collected at various sites, not involved in the systematic data-collection program, and are published as miscellaneous measurements. Also, one seepage investigation was published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New Mexico. (See also W90-06443) (USGS)
W90-06444

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
G. D. Firda, R. Lumia, R. J. Archer, and P. M. Burke.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-172540/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report NY-85-1 (WRD/HD-87-207), 1986. 268p. Prepared in cooperation with the State of New York and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents, and water quality of lakes and reservoirs; and water levels in observation wells. This volume contains records of water discharge at 97 gaging stations; stage only at 5 gaging stations; and stage and contents at 4 gaging stations and 19 lakes and reservoirs; water quality at 36 gaging stations; and water levels at 23 observation wells. Locations of these sites are shown. Also included are data for 66 crest-stage and 8 low-flow partial-record stations. Additional water data were collected at various sites not in the systematic data collection program and are published as miscellaneous measurements and analysis. These data, together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See W90-06446, W90-06447, and W90-06454) (USGS)
W90-06445

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985, VOLUME 2. LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
A. G. Spinello, J. H. Nakao, and R. B. Winowitch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-178240/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report NY-85-2 (WRD/HD-87-214), 1986. 304p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records of water discharge at 17 gaging stations; water quality at 16 gaging stations, 850 wells; and water levels at 139 observation wells. Also included are data for 79 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 1 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, Federal and other agencies in New York. (See W90-06445 and W90-06447) (USGS)
W90-06446

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1985. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
J. B. Hood, W. H. Johnston, W. E. Harding, and D. A. Sherwood.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-181863/AS. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report NY-85-3 (WRD/HD-87-208), 1985. 185p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Seepage, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 78 gaging stations; stage only at 19 gaging stations; stage and contents at 6 gaging stations; water quality at 7 gaging stations; and water levels at 21 observation wells. Also included are data for 67 crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in New York. (See W90-06445 and W90-06446) (USGS)
W90-06447

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
G. D. Firda, R. Lumia, and P. M. Burke.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-174388. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report NY-86-1 (WRD/HD-88-206), 1987. 262p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in observation wells. This volume contains records of water discharge at 97 gaging stations; stage only at 5 gaging stations; and stage and contents at 4 gaging stations and 19 lakes and reservoirs; water quality at 34 gaging stations; and

water levels at 24 observation wells. Locations of these sites are shown. Also included are data for 45 crest-stage partial-record stations. Additional water data were collected at various sites not in the systematic data collection program and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See W90-06445, W90-06449, and W90-06450) (USGS)
W90-06448

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 2: LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
A. G. Spinello, J. H. Nakao, D. L. Simmons, and R. B. Winowitch.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-174396. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report NY-86-2 (WRD/HD-87-274), 1987. 164p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 17 gaging stations; water quality at 16 gaging stations, 109 wells; and 3 precipitation stations; and water levels at 118 observation wells. Also included are data for 82 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 1 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, Federal and other agencies in New York. (See W90-06448 and W90-06450) (USGS)
W90-06449

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1986. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
W. F. Coon, W. H. Johnston, D. A. Sherwood, and D. D. Deloff.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-156258. Price codes: A10 in paper copy, A02 in microfiche. USGS Water-Data Report NY-86-3 (WRD/HD-87-275), 1986. 186p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 80 gaging stations; stage only at 19 gaging stations; stage and contents at 6 gaging stations; water quality at 7 gaging stations; and water levels at 22 observation wells. Also included are data for 67 crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in New York. (See W90-06448 and W90-06449) (USGS)
W90-06450

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
G. D. Firda, R. Lumia, and P. M. Burke.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-131379/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report NY-87-1 (WRD/HD-88-260), 1988. 267p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in observation wells. This volume contains records of water discharge at 97 gaging stations; stage only at 4 gaging stations; and stage and contents at 4 gaging stations, and 19 other lakes and reservoirs; water quality at 33 gaging stations; and water levels at 24 observation wells. Locations of these sites are shown. Also included are data for 35 crest-stage partial-record stations. Additional water data were collected at various sites not part of the systematic data collection program and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See W90-06448, W90-06452, and W90-06453) (USGS)
W90-06451

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 2: LONG ISLAND.
Geological Survey, Syosset, NY. Water Resources Div.
A. G. Spinello, J. H. Nakao, D. L. Simmons, and R. B. Winowitch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-114367/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report NY-87-2 (WRD/HD-88-247), 1988. 218p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 17 gaging stations; water quality at 17 gaging stations, 217 wells; and 3 precipitation stations; and water levels at 113 observation wells. Also included are data for 74 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 1 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, Federal and other agencies in New York. (See also W90-06451 and W90-06453) (USGS)
W90-06452

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1987. VOLUME 3: WESTERN NEW YORK.
Geological Survey, Ithaca, NY. Water Resources Div.
W. F. Coon, W. H. Johnston, D. A. Sherwood, and D. D. Deloff.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-249313/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report NY-87-3 (WRD/HD-88-253), 1987. 178p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 77 gaging stations; stage only at 19 gaging stations; stage and contents at 6 gaging stations; water quality at 8 gaging stations; and water levels at 21 observation wells. Also included are data for 38 crest-stage partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in New York. (See W90-06451 and W90-06452) (USGS)
W90-06453

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 1: EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
G. D. Firda, R. Lumia, R. J. Archer, and P. M. Burke.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-132784. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report NY-84-1 (WRD/HD-85/253), 1985. 249p. Prepared in cooperation with the State of New York and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for New York consist of records of stage, discharge, and water quality of streams; stage, discharge, and water quality of lakes and reservoirs; quality of precipitation, and water levels and quality of water in wells. This volume contains records of water discharge at 96 gaging stations; stage only at 5 gaging stations; and stage and contents at 4 gaging stations and 19 lakes and reservoirs; water quality at 34 gaging stations and 3 precipitation stations, and water levels at 24 observation wells. Locations of these sites are shown. Also included are data for 66 crest-stage partial-record stations. Additional water data were collected at various sites, not in the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 2 and 3, represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See W90-06455 and W90-06456) (USGS)
W90-06454

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 2. LONG ISLAND.

Geological Survey, Albany, NY. Water Resources Div.
A. G. Spinello, J. H. Nakao, W. J. Flipse, and J. G. Carcaci.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-137338. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report NY-84-2 (WRD/HD-85/246), 1985. 288p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of ground water wells. This report contains records for water discharge at 17 gaging stations; water quality at 17 gaging stations, 884 wells; and water levels at 139 observation wells. Also included are data for 79 low-flow partial-record stations. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements and analyses. These data together with the data in Volumes 1 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See W90-06454 and W90-06456) (USGS)
W90-06455

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1984. VOLUME 3. WESTERN NEW YORK.
Geological Survey, Albany, NY. Water Resources Div.
J. B. Hood, W. J. Johnston, and H. J. Zajd.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-130630. Price codes: A09 in paper copy, A01 in microfiche. USGS Water-Data Report NY-84-3 (WRD/HD-85/238), 1985. 184p. Prepared in cooperation with the State of New York and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for New York consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels of ground-water wells. This volume contains records for water discharge at 78 gaging stations; stage only at 14 gaging stations; stage and contents at 6 gaging stations; water quality at 7 gaging stations; and water levels at 22 observation wells. Also included are data for 63 crest-stage partial-record stations. Additional water data were collected at various sites, not involved in the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 1 and 2 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See W90-06454 and W90-06455) (USGS)
W90-06456

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1985.
Geological Survey, Raleigh, NC. Water Resources Div.
C. L. Hill, J. F. Rinehardt, and T. E. Dillard.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-111894. Price codes: A24 in paper copy, A01 in microfiche. USGS Water-Data Report NC-85-1 (WRD/HD-86/223), 1985. 550p. Prepared in cooperation with the State of North Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for North Carolina consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 154 gaging stations and stage and contents for 25 lakes and reservoirs; water quality for 137 gaging stations and 12 miscellaneous sites; and water levels for 68 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements in this report. The collection of water-resources data in North Carolina is a part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, Municipal, and Federal agencies. (USGS)
W90-06457

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1984.
Geological Survey, Bismarck, ND. Water Resources Div.
N. D. Haffield, and G. L. Ryan.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-159282. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report ND-84-1 (WRD/HD-85/271), 1985. 358p. Prepared in cooperation with the State of North Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for North Dakota consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 108 gaging stations; stage only records for 21 gaging stations; stage and contents for 13 lakes and reservoirs; water quality for 108 gaging stations, 8 lakes, 33 wells, 2 precipitation stations; and water levels for 31 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and local agencies in North Dakota. (USGS)
W90-06458

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1985.
Geological Survey, Bismarck, ND. Water Resources Div.
R. E. Harkness, N. D. Haffield, and G. L. Ryan.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-118642. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report ND-85-1 (WRD/HD-86/254), 1986. 368p. Prepared in cooperation with the State of North Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for North Dakota consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 105 gaging stations; stage only records for 21 gaging stations; stage and contents for 15 lakes and reservoirs; water quality for 103 gaging stations, 7 lakes, 3 crest-stage gages, 76 wells; and water levels for 31 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and local agencies in North Dakota. (See also W90-06458) (USGS)
W90-06459

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1984. VOLUME 1. OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, L. L. Stewart, and J. R. Kolva.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-233500. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report OH-84-1 (WRD/HD-85/222), 1985. 316p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Water wells.

Water resources data for the 1984 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report in two volumes contains records for water discharge at 127 gaging stations, stage and contents at 4 lakes and reservoirs; water quality at 31 gaging stations, 32 wells, and 14 partial record sites; and water levels at 387 observation wells. Also included are data from 60 crest-stage partial-record stations and 4 miscellaneous sites. Additional water data were collected at various sites, not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See also W90-06461) (USGS)
W90-06460

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1984. VOLUME 2. ST. LAWRENCE RIVER BASIN, STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, L. L. Stewart, and J. R. Kolva.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-230233. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report OH-84-2 (WRD/HD-85/223), 1985. 224p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report in two volumes contains records for water discharge at 127 gaging stations; stage and contents at 4 lakes and reservoirs; water quality at 31 gaging stations, 32 wells, and 14 partial record sites; and water levels at 387 observation wells. Also included are data from 60 crest-stage partial-record stations and 4 miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See also W90-06460) (USGS)

W90-06461

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1985. VOLUME 1. OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klinqler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161, Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report OH-85-1 (WRD/HD-86/231), 1986. 338p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report in two volumes contains records for water discharge at 136 gaging stations, stage and contents at 4 lakes and reservoirs; water quality at 32 gaging stations, 87 wells, and 5 partial record sites; and water levels at 460 observation wells. Also included are data from 61 crest-stage partial-record stations and 19 miscellaneous sites. Additional water data were collected at various sites, not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See W90-06460 and W90-06463) (USGS)
W90-06462

WATER RESOURCES DATA FOR OHIO, WATER YEAR 1985. VOLUME 2. ST. LAWRENCE RIVER BASIN, STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-111324. Price codes: A13 in paper copy, A13 in microfiche. USGS Water-Data Report OH-85-2 (WRD/HD-86/232), 1986. 281p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report in two volumes contains records for water discharge at 136 gaging stations, stage and contents at 4 lakes and reservoirs; water quality at 32 gaging stations, 87 wells, and 5 partial record sites; and water levels at 460 observation wells. Also included are data from 61 crest-stage partial-record stations and 19 miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See also W90-06462) (USGS)
W90-06463

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1983.
Geological Survey, Oklahoma City, OK. Water Resources Div.
L. D. Hauth, J. K. Kurklin, and D. M. Walters.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-236289. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report OK-83-1 (WRD/HD-85/217), 1985. 286p. Prepared in cooperation with the State of Oklahoma and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oklahoma, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1983 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs. This report contains discharge records for 117 gaging stations; stage and contents for 27 lakes or reservoirs; water quality for 39 gaging stations and 3 lakes. Also included are 39 crest-stage partial-record stations and 3 low-flow stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (USGS)
W90-06464

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1984.
Geological Survey, Oklahoma City, OK. Water Resources Div.
L. D. Hauth, J. K. Kurklin, and D. M. Walters.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-149944/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report OK-84-1 (WRD/HD-86/235), 1986. 302p. Prepared in cooperation with the State of Oklahoma and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oklahoma, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1984 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs. This report contains discharge records for 122 gaging stations; stage and contents for 28 lakes or reservoirs; water quality for 36 gaging stations and 3 lakes. Also included are 39 crest-stage partial-record stations and 3 low-flow stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (See also W90-06464) (USGS)
W90-06465

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1984. VOLUME 1. EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. L. Hubbard, M. L. Smith, and L. E. Hubbard.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-115986. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report OR-84-1 (WRD/HD-86/217), 1986. 224p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Oregon consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report, in two volumes, contains discharge records for 259 gaging stations; stage only records for 8 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 96 stations, water levels for 59 observation wells; and water quality for 3 precipitation stations. Also included are 13 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-06467) (USGS)
W90-06466

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1984. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. L. Hubbard, M. L. Smith, and L. E. Hubbard.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-111860. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report OR-84-2 (WRD/HD-86/218), 1986. 467p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Oregon consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report, in two volumes, contains discharge records for 259 gaging stations; stage only records for 8 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 96 stations, water levels for 59 observation wells; and water quality for 3 precipitation stations. Also included are 13 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-06466) (USGS)
W90-06467

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. R. Kolva, T. E. White, R. L. Druther, and P. Moleski.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-162534. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report PA-84-1 (WRD/HD-86/206), 1985. 261p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for Pennsylvania consist of records of stage, discharge, and water quality of streams; elevation and contents of lakes and reservoirs; and elevation of tides; and water levels of groundwater wells. This volume contains records for water discharge at 68 gaging stations; elevation and contents at 12 lakes and reservoirs; elevation of tides at 3 gaging stations; water quality at 33 gaging stations; and water levels at 17 observation wells. Also included are data for 33 crest-stage, 53 low-flow, and 42 water-quality partial-record stations. Location of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published

as miscellaneous measurements and analysis. These data together with the data in Volumes 2 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See W90-06469 and W90-06499) (USGS)
W90-06468

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. B. Lescinsky, M. B. Coll, and R. W. Siwicki.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-239606. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report PA-84-3 (WRD/HD-85/228), 1985. 207p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for Pennsylvania consist of records of discharge, and water quality of streams; elevation and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 83 gaging stations; elevations and contents at 3 lakes and reservoirs; and water levels at 39 observation wells. Also included are data for 3 crest-stage, 5 low-flow stations, 50 water quality and 85 groundwater-quality partial-record stations. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program and are published as miscellaneous measurements and analysis. These data, together with the data in Volume 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See also W90-06468 and W90-06499) (USGS)
W90-06469

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1984.
Geological Survey, Huron, SD. Water Resources Div.
E. B. Hoffman, R. D. Benson, and G. R. Wisnieski.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-130507. Price codes: A12 in paper copy, A01 in microfiche. USGS Water-Data Report SD-84-1 (WRD/HD-85/266), 1985. 259p. Prepared in cooperation with the State of South Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for South Dakota consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 105 gaging stations, stage and contents for 13 lakes and reservoirs; water quality for 17 gaging stations; and water levels for 37 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Dakota. (USGS)
W90-06470

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1985.
Geological Survey, Huron, SD. Water Resources Div.
E. B. Hoffman, R. D. Benson, and G. R. Wisnieski.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-152062/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report SD-85-1 (WRD/HD-86/265), 1986. 265p. Prepared in cooperation with the State of South Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for South Dakota consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 115 streamflow-gaging stations; stage and contents records for 10 lakes and reservoirs, stage for 2 streams and 1 lake; water quality records for 30 stream-gaging stations, 3 wells, 5 ungaged streamsites, 4 lakes, and 4 sewage lagoons; and water levels for 30 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analysis. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Dakota. (See also W90-06470) (USGS)
W90-06471

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1984.
Geological Survey, Nashville, TN. Water Resources Div.
J. F. Lowery, P. H. Counts, H. L. Edmiston, and F. D. Edwards.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-232338. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report TN-84-1 (WRD/HD-85/216), 1985. 331p. Prepared in cooperation with the State of Tennessee and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Tennessee, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Seepage, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Tennessee consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of wells. This report contains discharge records for 91 gaging stations; stage only records for 2 lake gaging stations; elevation and contents for 28 lakes and reservoirs; water quality for 22 stations; and water levels for 32 observation wells. Also included are 93 crest-stage partial-record stations and 79 low-flow partial-record stations. Additional water data were collected at various stream and spring sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses, or as seepage investigations of discharge and water quality. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Tennessee. (USGS)
W90-06472

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1984. VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-130267. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report TX-84-1 (WRD/HD-85/249), 1985. 485p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Surface-water data for the 1984 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06474 and W90-06475) (USGS)
W90-06473

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1984. VOLUME 2. SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-128592. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-84-2 (WRD/HD-85/250), 1985. 427p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Surface-water data for the 1984 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06473 and W90-06475) (USGS)
W90-06474

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1984. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-135167. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-84-3 (WRD/HD-85/251), 1985. 429p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Surface-water data for the 1984 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; stage, contents and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06473 and W90-06474) (USGS)
W90-06475

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1984.
Geological Survey, Salt Lake City, UT. Water Resources Div.
M. D. ReMillard, G. C. Andersen, G. A. Birdwell, and E. Hookano.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-126968. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report UT-84-1 (WRD/HD-85/241), 1985. 463p. Prepared in cooperation with the State of Utah and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Utah, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Utah consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 221 gaging stations; stage and contents for 18 lakes and reservoirs; water quality for 48 hydrologic stations and 166 wells; miscellaneous temperature measurements and field determinations for 162 stations; and water levels for 36 observation wells. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Utah. (USGS)
W90-06476

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1985.
Geological Survey, Salt Lake City, UT. Water Resources Div.
M. D. ReMillard, G. C. Andersen, G. A. Birdwell, and G. W. Sandberg.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-152369/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report UT-85-1 (WRD/HD-86/250), 1986. 400p. Prepared in cooperation with the State of Utah and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Utah, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Utah consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 198 gaging stations; stage and contents for 17 lakes and reservoirs; water quality for 24 hydrologic stations and 186 wells; miscellaneous temperature measurements and field determinations for 157 stations; and water levels for 31 observation wells. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Utah. (See also W90-06476) (USGS)
W90-06477

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1984.
Geological Survey, Richmond, VA. Water Resources Div.
B. J. Prugh, F. J. Easton, and D. D. Lynch.
Available from the National Technical Information Service, Springfield, VA 22161, as PB85-242105. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report VA-84-1 (WRD/HD-85/226), 1985. 405p. Prepared in cooperation with the State of Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Virginia, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Virginia consist of records of stage, discharge, and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains records for water discharge at 192 gaging stations; stage only at 1 gaging station; stage and contents at 10 lakes and reservoirs; water quality at 43 gaging stations and 5 wells; and water levels at 56 observation wells. Also included are data for 78 crest-stage partial-record stations. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program. Discharge measurements were made at 172 low-flow partial-record stations. Miscellaneous data were collected at 133 measuring sites and 31 water-quality sampling sites. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Virginia. (USGS)
W90-06478

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1986.
Geological Survey, Raleigh, NC. Water Resources Div.
R. G. Barker, W. H. Eddins, R. G. Garrett, B. C. Ragland, and J. F. Rinehardt.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-231049/AS. Price codes: A22 in paper copy, A01 in microfiche. USGS Water-Data Report NC-86-1 (WRD/HD-87/233), 1986. 495p. Prepared in cooperation with the State of North Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for North Carolina consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 159 gaging stations and stage and contents for 25 lakes and reservoirs; water quality for 130 gaging stations and 8 miscellaneous sites; and water levels for 73 observation wells. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements in this report. The collection of water-resources data in North Carolina is a part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, municipal, and Federal agencies. (See also W90-06457) (USGS)
W90-06479

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1987.
Geological Survey, Raleigh, NC. Water Resources Div.
B. C. Ragland, R. G. Garrett, R. G. Barker, W. H. Eddins, and J. F. Rinehardt.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-212550/AS. Price codes: A23 in paper copy, A01 in microfiche. USGS Water-Data Report NC-87-1 (WRD/HD-88/218), 1987. 542p. Prepared in cooperation with the State of North Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for North Carolina consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 173 gaging stations and stage and contents for 25 lakes and reservoirs; water quality for 140 gaging stations and 21 miscellaneous sites; and water levels for 72 observation wells. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements in this report. The collection of water-resources data in North Carolina is a part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, municipal, and Federal agencies. (See also W90-06479) (USGS)
W90-06480

WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1988.
Geological Survey, Raleigh, NC. Water Resources Div.
B. C. Ragland, R. G. Garrett, R. G. Barker, W. H. Eddins, and J. F. Rinehardt.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-204333/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report NC-88-1 (WRD/HD-89/228), 1989. 418p. Prepared in cooperation with the State of North Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for North Carolina consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and groundwater levels. This report contains discharge records for 171 gaging stations and stage and contents for 26 lakes and reservoirs; water quality for 35 gaging stations and 10 miscellaneous sites; and water levels for 43 observation wells. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements in this report. The collection of water-resources data in North Carolina is a part of the National Water Data System operated by the U.S. Geological Survey in cooperation with State, municipal, and Federal agencies. (See also W90-06480) (USGS)
W90-06481

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1986.
Geological Survey, Bismarck, ND. Water Resources Div.

R. E. Harkness, N. D. Haffield, and G. L. Ryan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-102231/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report ND-86-1 (WRD/HD-87/226), 1987. 399p. Prepared in cooperation with the State of North Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for North Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 107 gaging stations; stage only records for 22 gaging stations; stage and contents for 14 lakes and reservoirs; peak flow data for 10 crest-stage gages; water quality data for 100 gaging stations, 8 lakes, 10 crest-stage gages, 68 wells; and water levels for 31 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal and local agencies in North Dakota. (See also W90-06459) (USGS)
W90-06482

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1987.
Geological Survey, Bismarck, ND. Water Resources Div.
R. E. Harkness, N. D. Haffield, and G. L. Ryan.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-217484. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report ND-87-1 (WRD/HD-88/226), 1988. 392p. Prepared in cooperation with the State of North Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for North Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 104 gaging stations; stage only records for 22 gaging stations; contents and/or stage for 15 lakes and reservoirs; peak flow data for 17 crest-stage gages; water quality data for 102 gaging stations, 4 lakes, 13 crest-stage gages, 50 wells; and water levels for 31 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal and local agencies in North Dakota. (See also W90-06482) (USGS)
W90-06483

WATER RESOURCES DATA FOR NORTH DAKOTA, WATER YEAR 1988.
Geological Survey, Bismarck, ND. Water Resources Div.
R. E. Harkness, N. D. Haffield, G. L. Ryan, and E. A. Wesolowski.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194997. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report ND-88-1 (WRD/HD-89/238), 1989. 380p. Prepared in cooperation with the State of North Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *North Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for North Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report contains discharge records for 105 gaging stations; stage only records for 22 gaging stations; contents and/or stage for 14 lakes and reservoirs; peak flow data for 15 crest-stage gages; water quality data for 96 gaging stations, 8 lakes, 13 crest-stage gages, 30 wells; and water levels for 31 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal and local agencies in North Dakota. (See also W90-06483) (USGS)
W90-06484

WATER RESOURCES DATA FOR OHIO, 1986. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-144704/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report OH-86-1 (WRD/HD-87/237), 1987. 295p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, in two volumes, contains records for water discharge records at 125 gaging stations, stage and contents at 4 lakes and reservoirs, water quality at 17 gaging stations, 100 wells, and 60 partial-record sites; and water levels at 948 observation wells. Also included are data from 59 crest-stage partial-record stations and 19 miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See also W90-06412 and W90-06486) (USGS)
W90-06485

WATER RESOURCES DATA FOR OHIO, 1986. VOLUME 2: ST. LAWRENCE RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-144696/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report OH-86-2 (WRD/HD-87/268), 1987. 287p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, in two volumes, contains records for water discharge records at 125 gaging stations, stage and contents at 4 lakes and reservoirs, water quality at 17 gaging stations, 100 wells, and 60 partial-record sites; and water levels at 948 observation wells. Also included are data from 59 crest-stage partial-record stations and 19 miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See also W90-06485) (USGS)
W90-06486

WATER RESOURCES DATA FOR OHIO, 1987. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-221676. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report OH-87-1 (WRD/HD-88/227), 1988. 319p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, in two volumes, contains records for water discharge records at 123 gaging stations, stage and contents at 8 lakes and reservoirs, water quality at 25 gaging stations, 196 wells, and 93 partial-record sites; and water levels at 828 observation wells. Also included are data from 31 crest-stage partial-record stations and 89 miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See W90-06485 and W90-06488) (USGS)
W90-06487

WATER RESOURCES DATA FOR OHIO, 1987. VOLUME 2: ST. LAWRENCE RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-223110/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report OH-87-2 (WRD/HD-88/233), 1987. 342p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, in two volumes, contains records for water discharge records at 123 gaging stations, stage and contents at 8 lakes and reservoirs, water quality at 25 gaging stations, 196 wells, and 93 partial-record sites; and water levels at 828 observation wells. Also included are data from 31 crest-stage partial-record stations and 89 miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geologi-

cal Survey and cooperating State and Federal agencies in Ohio. (See also W90-06487) (USGS)
W90-06488

WATER RESOURCES DATA FOR OHIO, 1988. VOLUME 1: OHIO RIVER BASIN.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161. USGS Water-Data Report OH-88-1 (WRD/HD-89/241), 1989. 298p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, in two volumes, contains records for water discharge records at 133 gaging stations, stage and contents at 9 lakes and reservoirs, water quality at 34 gaging stations, 59 wells, and 47 partial-record sites; and water levels at 450 observation wells. Also included are data from miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See W90-06487 and W90-06490) (USGS)
W90-06489

WATER RESOURCES DATA FOR OHIO, 1988. VOLUME 2: ST. LAWRENCE RIVER BASIN AND STATEWIDE PROJECT DATA.
Geological Survey, Columbus, OH. Water Resources Div.
H. L. Shindel, J. H. Klingler, J. P. Mangus, and L. E. Trimble.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-194989. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report OH-88-2 (WRD/HD-89/242), 1989. 204p. Prepared in cooperation with the State of Ohio and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Ohio, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, in two volumes, contains records for water discharge records at 133 gaging stations, stage and contents at 9 lakes and reservoirs, water quality at 34 gaging stations, 59 wells, and 47 partial-record sites; and water levels at 450 observation wells. Also included are data from miscellaneous sites. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (See also W90-06489) (USGS)
W90-06490

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1985.
Geological Survey, Oklahoma City, OK. Water Resources Div.
L. D. Hauth, J. K. Kurklin, D. M. Walters, and T. E. Coffey.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-103098/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report OK-85-1 (WRD/HD-87/222), 1985. 302p. Prepared in cooperation with the State of Oklahoma and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oklahoma, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1985 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs. This report contains discharge records for 122 gaging stations; stage and contents for 29 lakes or reservoirs; water quality for 41 gaging stations and 3 lakes. Also included are 30 crest-stage partial-record stations and 3 low-flow stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (See also W90-06465) (USGS)
W90-06491

WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1986.
Geological Survey, Oklahoma City, OK. Water Resources Div.
L. D. Hauth, J. K. Kurklin, D. M. Walters, and T. E. Coffey.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-241583/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report OK-86-1 (WRD/HD-88/228), 1986. 316p. Prepared in cooperation with the State of Oklahoma and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oklahoma, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water temperature.

Water resources data for the 1986 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs. This report contains discharge records for 126 gaging stations; stage and contents for 29 lakes or reservoirs; water quality for 40 gaging stations and 3 lakes. Also included are 3 partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (See also W90-06491) (USGS)
W90-06492

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1982. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. L. Hubbard, T. D. Parks, D. L. Weiss, and L. E. Hubbard.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-164326/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report OR-82-1, 1983. 206p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Columbia River, Flow rates, Gaging stations, Great Basin, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1982 water year for Oregon consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report, in two volumes, contains discharge records for 253 gaging stations; stage only records for 8 gaging stations; stage and contents for 37 lakes and reservoirs; water quality for 81 gaging stations, water levels for 57 observation wells; and water quality for 4 precipitation stations. Also included are 33 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-06494) (USGS)
W90-06493

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1982. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. L. Hubbard, T. D. Parks, D. L. Weiss, and L. E. Hubbard.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-164334/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report OR-82-2, 1983. 419p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Columbia River, Flow rates, Gaging stations, Lakes, Pacific slope basins, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1982 water year for Oregon consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report, in two volumes, contains discharge records for 253 gaging stations; stage only records for 8 gaging stations; stage and contents for 37 lakes and reservoirs; water quality for 81 gaging stations, water levels for 57 observation wells; and water quality for 4 precipitation stations. Also included are 33 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-06493) (USGS)
W90-06494

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1985. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
C. W. Alexander, R. L. Moffatt, P. R. Boucher, and M. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-103114/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report OR-85-1 (WRD/HD-87/241), 1987. 218p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 259 gaging stations; stage only records for 10 gaging stations; stage and contents for 37 lakes and reservoirs; water quality for 82 stations, and water quality for 3 precipitation stations. Also included are 5 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are

published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See W90-06466 and W90-06496) (USGS)
W90-06495

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1985. VOLUME 2: WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
C. W. Alexander, R. L. Moffatt, P. R. Boucher, and M. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-103122/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report OR-85-2 (WRD/HD-87/242) 1987. 396p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs; This report, in two volumes, contains discharge records for 259 gaging stations; stage only records for 10 gaging stations; stage and contents for 37 lakes and reservoirs; water quality for 82 stations, water levels for 3 precipitation stations. Also included are 5 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-06495) (USGS)
W90-06496

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1986. VOLUME 1: EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
C. W. Alexander, P. R. Boucher, R. L. Moffatt, and M. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-139984/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report OR-86-1 (WRD/HD-89/202), 1988. 232p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 269 gaging stations; stage only records for 10 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 78 stations, water levels for 3 precipitation stations. Also included are 5 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See W90-06495 and W90-06498) (USGS)
W90-06497

WATER RESOURCES DATA FOR OREGON WATER YEAR 1986, VOLUME 2. WESTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
C. W. Alexander, R. L. Kraus, C. G. Kroll, R. L. Moffatt, and M. L. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-139992/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report OR-86-2 (WRD/HD-89/203), 1988. 398p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and water quality of lakes and reservoirs; This report, in two volumes, contains discharge records for 269 gaging stations; stage only records for 10 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 78 stations, and water quality for 3 precipitation stations. Also included are 5 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-06497) (USGS)
W90-06498

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1984. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
W. C. Loper, T. E. Behrendt, W. P. Schaffstall, and R. A. Hainly.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-212411/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report PA-84-2 (WRD/HD-85/248), 1985. 327p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1984 water year for Pennsylvania consist of records of discharge and water quality of streams; contents of lakes and reservoirs; and water levels, and water quality of groundwater wells. This volume contains water discharge at 87 stations; contents at 13 lakes and reservoirs, water quality at 17 gaging stations; and water levels at 24 network observation wells and 6 project wells. Also included are data for 13 crest-stage and 48 low-flow stations. Water quality data for 2 surface water and 41 groundwater partial-record stations are also published. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses and represent 115 discharge sites, 98 surface-water quality sites and 39 groundwater quality sites. These data, together with the data in Volumes 1 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See W90-06468 and W90-06469) (USGS)
W90-06499

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. R. Kolva, T. E. White, R. L. Druther, and P. Moleski.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-223137/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report PA-85-1 (WRD/HD-87/230), 1987. 269p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year for Pennsylvania consist of records of discharge and water quality of streams; elevation and contents of lakes and reservoirs elevation of tides; and water levels of groundwater wells. This volume contains records for water discharge at 68 gaging stations; elevation and contents at 12 lakes and reservoirs; elevation of tides at 4 gaging stations; water quality at 33 gaging stations; and water levels at 17 observation wells. Also included are data for 33 crest-stage, 51 low-flow, and 42 water quality partial-record stations. Location of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating state, local and Federal agencies in Pennsylvania. (See W90-06468, W90-06501, and W90-06502) (USGS)
W90-06500

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
W. C. Loper, T. E. Behrendt, W. P. Schaffstall, and R. A. Hainly.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-138094/AS; price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report PA-85-2 (WRD/HD-87/266), 1987. 361p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year for Pennsylvania consist of records of discharge and water quality of streams; contents of lakes and reservoirs; and water levels, and water quality of groundwater wells. This volume contains records for water discharge at 95 stations; contents at 13 lakes and reservoirs, water quality at 33 gaging stations; and water levels at 25 network observation wells and 12 project wells. Also included are data for 13 crest-stage and 96 low-flow stations. Water quality data for 2 surface water and 21 water level stations are also published. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses and represent 10 discharge sites, and 115 groundwater quality sites. These data together with the data in Volume 1 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See W90-06500 and W90-06502) (USGS)
W90-06501

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1985. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. B. Lescinsky, M. B. Coll, and R. W. Siwicki.

Available from the National Technical Information Service, Springfield, VA 22161 as PB87-178232/AS; price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report PA-85-3 (WRD/HD-86/251), 1986. 191p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1985 water year for Pennsylvania consist of records of discharge and water quality of streams; elevation and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 82 gaging stations; elevations and contents at 3 lakes and reservoirs; and water levels at 39 observation wells. Also included are data for 3 crest-stage, 5 low-flow stations, 43 water quality and 10 groundwater-quality partial-record stations. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See W90-06500 and W90-06501) (USGS)
W90-06502

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. R. Kolva, T. E. White, L. D. Cecil, and R. L. Druther.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-131361/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report PA-86-1 (WRD/HD-88/281), 1988. 294p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, *Wells, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Pennsylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality of groundwater wells. This report, includes records from the Delaware River basins. Specifically, it contains: (1) Discharge records for 74 continuous record streamflow-gaging stations and 72 partial-record stations; (2) Elevation and contents records for 12 lakes and reservoirs and elevations for 4 tidal stations; (3) Water quality records for 40 streamflow-gaging stations, for 43 ungaged streamsites, and (4) Water level records for 17 observation wells. The locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses. These data together with the data in Volume 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See W90-06500, W90-06504 and W90-06505) (USGS)
W90-06503

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
W. C. Loper, T. E. Behrendt, and W. P. Schaffstall.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-241328/AS: Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report PA-86-2 (WRD/HD-87/241), 1988. 330p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year for Pennsylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality of groundwater wells. This report includes records from the Susquehanna and Potomac River basins. Specifically, it contains: (1) Discharge records for 93 continuous record stream-flow-gaging stations and 12 crest-stage partial-record stations; (2) Elevation and contents records for 13 lakes and reservoirs; (3) Water quality records for 22 streamflow-gaging stations, for 8 ungaged streamsites, and for 30 wells or springs; and (4) Water level records for 41 observation wells. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program and are published as miscellaneous measurements and analyses and represent 3 special study and miscellaneous streamflow sites and 22 groundwater quality sites. These data together with the data in Volumes 1 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See also W90-6503 and W90-06505) (USGS)
W90-06504

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1986. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. B. Lescinsky, M. B. Coll, and R. W. Siwicki.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-100416/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report PA-86-3 (WRD/HD-88/211), 1987. 205p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1986 water year for Pennsylvania consist of records of discharge and water quality of streams; elevation and contents of lakes and reservoirs; and water levels of observation wells. This volume contains records for water discharge at 82 gaging stations; elevations and contents at 3 lakes and reservoirs; and water levels at 20 observation wells. Also included are data for 4 crest-stage, 5 low-flow stations, and 51 water quality stations. Locations of these sites are shown. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local and Federal agencies in Pennsylvania. (See W90-06503 and W90-06504) (USGS)
W90-06505

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1987. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. R. Kolva, T. E. White, R. L. Druther, and P. Moleski.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-207526/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report PA-87-1 (WRD/HD-89/246), 1989. 290p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Pennsylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality of groundwater wells. This report includes records from the Delaware River basins. Specifically, it contains: (1) Discharge records for 77 continuous record streamflow-gaging stations and 57 partial-record stations; (2) Elevation and contents records for 12 lakes and reservoirs and elevation for 4 tidal stations; (3) Water quality records for 39 streamflow-gaging station, and for 43 ungaged streamsites, and (4) Water-level records for 16 observation wells. Locations of these sites are shown. Additional water data were collected at various sites not part of the systematic data collection program and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Pennsylvania. (See W90-06503 and W90-06507) (USGS)
W90-06506

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1987. VOLUME 3, OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. B. Lescinsky, M. B. Coll, and R. W. Siwicki.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-149678/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report PA-87-3 (WRD/HD-89-212), 1988. 233p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Pennsylvania consist of records of discharge and water quality of streams; elevation and contents of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 81 gaging stations; elevations and contents at 3 lakes and reservoirs; and water levels at 35 observation wells. Also included are data for 3 crest-stage, 7 partial-record or miscellaneous streamflow stations and water quality records for 8 streamflow-gaging stations and 25 water quality stations. Locations of these sites are shown. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Pennsylvania. (See also W90-06506) (USGS)
W90-06507

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 1: DELAWARE RIVER BASIN.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. R. Kolva, T. E. White, R. L. Druther, and K. E. White.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-232433/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report PA-88-1 (WRD/HD-89-272), 1989. 275p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year for Pennsylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality of groundwater wells. This report includes records from the Delaware River basins. Specifically, it contains (1) discharge records for 80 continuous record streamflow-gaging stations and 74 partial-record stations; (2) elevation and contents records for 12 lakes and reservoirs and elevations for 1 tidal station; (3) water quality records for 32 gaging stations, for 39 ungaged streamsites; and (4) water-level records for 17 observation wells. Locations of these sites are shown. Additional water data were collected at various sites not part of the systematic data collection program and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Pennsylvania. (See W90-06506, W90-06509 and W90-06510) (USGS)
W90-06508

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 2: SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
W. C. Loper, T. E. Behrendt, and W. P. Schaffstall.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-214704/AS. Price codes: A13 in paper copy, A01 in microfiche. USGS Water-Data Report PA-88-2 (WRD/HD-89/259), 1989. 276p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1987 water year for Pennsylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels and water quality of groundwater wells. This report includes records from the Susquehanna and Potomac River basins. Specifically, it contains: (1) Discharge records for 99 continuous record streamflow-gaging stations and 14 crest-stage partial-record stations; (2) Elevation and contents records for 13 lakes and reservoirs; (3) Water quality records for 17 streamflow-gaging stations, for 10 ungaged streamsites, and for 16 wells or springs; and (4) Water-level records for 39 observation wells. Locations of these sites are shown. Additional water data were collected at various sites not part of the systematic data collection program and are published as miscellaneous measurements and analyses and represent 4 special study and miscellaneous streamflow sites. These data, together with the data in Volumes 1 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Pennsylvania. (See also W90-06508 and W90-06510) (USGS)
W90-06509

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1988. VOLUME 3: OHIO RIVER AND ST. LAWRENCE RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
J. B. Lescinsky, M. B. Coll, and R. W. Siwicki.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-224026/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report PA-88-3 (WRD/HD-89/265), 1989. 217p. Prepared in cooperation with the State of Pennsylvania and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Pennsylvania, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature, Wells.

Water resources data for the 1988 water year for Pennsylvania consist of records of discharge and water quality of streams; contents and elevations of lakes and reservoirs; and water levels of groundwater wells. This report includes records from the Ohio and St. Lawrence River basins. Specifically, it contains: (1) Discharge records for 82 continuous record streamflow-gaging stations and 29 partial-record stations; (2) Elevation and contents records for 3 lakes and reservoirs; (3) Water quality records for 14 streamflow-gaging stations, for 47 ungaged streamsites, and (4) Water-level records for 20 network observation wells and 18 project wells. Locations of these sites are shown. Additional water data were collected at various sites not part of the systematic data collection program and are published as miscellaneous measurements and analyses. These data, together with the data in Volumes 1 and 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Pennsylvania. (See also W90-06508 and W90-06510) (USGS)
W90-06510

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1985.
Geological Survey, San Juan, PR. Water Resources Div.
E. Colon-Dieppa, R. Garcia, and P. Diaz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-136569/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report PR-85-1 (WRD/HD-87/252), 1987. 400p. Prepared in cooperation with the Commonwealth of Puerto Rico, the Government of the Virgin Islands and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Puerto Rico, *Surface water, *Virgin Islands(US), *Water quality, Aquifers, Chemical analysis, Gaging stations, Lakes, Sampling sites, Sediments, Streamflow, Water analysis, Water level.

Water resources data for surface-water, quality-of-water, and groundwater records for the 1985 water year for Puerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 57 streamflow-gaging stations, 131 partial-record or miscellaneous streamflow stations, and 1 crest-stage, partial-record streamflow station; stage and content records for 4 lakes and reservoirs; water quality records for 16 streamflow-gaging stations, 45 ungaged streamsites, 11 lake sites, 1 lagoon, and 1 bay; and water level records for 94 observation wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating local and Federal agencies in Puerto Rico and the U.S. Virgin Islands. (USGS)
W90-06511

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1986.
Geological Survey, San Juan, PR. Water Resources Div.
R. E. Curtis, Z. Aquino, R. Garcia, and P. Diaz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-113161/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report PR-86-1 (WRD/HD-88/220), 1988. 362p. Prepared in cooperation with the Commonwealth of Puerto Rico, the Government of the Virgin Islands and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Puerto Rico, *Surface water, *Virgin Islands(US), *Water quality, Aquifers, Chemical analysis, Gaging stations, Lakes, Sampling sites, Sediments, Streamflow, Water analysis, Water level.

Water resources data for surface-water, quality-of-water, and groundwater records for the 1986 water year for Puerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 50 streamflow-gaging stations, and 2 crest-stage, partial-record streamflow stations; stage records for 1 lagoon; water quality records for 16 streamflow-gaging stations, 45 ungaged streamsites, 11 lakes sites, 1 lagoon, and 1 bay; and water level records for 57 observation wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating local and Federal agencies in Puerto Rico and the U.S. Virgin Islands. (See also W90-06511) (USGS)
W90-06512

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1987.
Geological Survey, San Juan, PR. Water Resources Div.
R. E. Curtis, Z. Aquino, R. J. Vachier, and P. L. Diaz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-104597/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report PR-87-1 (WRD/HD-89/266), 1989. 356p. Prepared in cooperation with the Commonwealth of Puerto Rico, the Government of the Virgin Islands and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Puerto Rico, *Surface water, *Virgin Islands(US), *Water quality, Aquifers, Chemical analysis, Gaging stations, Lakes, Sampling sites, Sediments, Streamflow, Water analysis, Water level.

Water resources data for surface-water, quality-of-water, and groundwater records for the 1987 water year for Puerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 49 streamflow-gaging stations, and 1 crest-stage, partial-record streamflow station; water quality records for 16 streamflow-gaging stations, 42 ungaged streamsites, 11 lakes sites, 1 lagoon, and 1 bay; and water level records for 56 observation wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating local and Federal agencies in Puerto Rico and the U.S. Virgin Islands. (See also W90-06512) (USGS)
W90-06513

WATER RESOURCES DATA FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS, WATER YEAR 1988.
Geological Survey, San Juan, PR. Water Resources Div.
R. E. Curtis, Z. Aquino, R. J. Vachier, and P. L. Diaz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-140310/AS. Price codes: A21 in paper copy, A03 in microfiche. USGS Water-Data Report PR-88-1 (WRD/

HD-89/280), 1989. 460p. Prepared in cooperation with the Commonwealth of Puerto Rico, the Government of the Virgin Islands and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Puerto Rico, *Surface water, *Virgin Islands(US), *Water quality, Aquifers, Chemical analysis, Gaging stations, Lakes, Sampling sites, Sediments, Streamflow, Water analysis, Water level.

Water resources data for surface-water, quality-of-water, and groundwater records for the 1988 water year for Puerto Rico and the U.S. Virgin Islands, consist of records of discharge, water quality of streams, and water levels of wells. This report contains discharge records for 52 streamflow-gaging stations, stage records for 5 reservoirs; water quality records for 16 streamflow-gaging stations, 42 ungaged streamsites, 11 lakes sites, 2 lagoons, and 1 bay; and water level records for 63 observation wells. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating local and Federal agencies in Puerto Rico and the U.S. Virgin Islands. (See also W90-06513) (USGS)
W90-06514

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1985.
Geological Survey, Columbia, SC. Water Resources Div.
C. S. Bennett, R. D. Hayes, J. W. Gissendanner, and K. H. Jones.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-178893/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report SC-85-1 (WRD/HD-87/213), 1986. 412p. Prepared in cooperation with the State of South Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for South Carolina consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 98 gaging stations, stage only at 5 gaging stations, stage and contents at 12 lakes and reservoirs, water quality at 54 gaging stations, and water levels at 61 observation wells. Also included are data for 40 crest-stage partial-record stations. Locations of these sites are shown. Additional water data were collected at various sites not part of the systematic data collection program. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in South Carolina. (USGS)
W90-06515

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1986.
Geological Survey, Columbia, SC. Water Resources Div.
C. S. Bennett, R. D. Hayes, K. H. Jones, and T. W. Cooney.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-181615/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report SC-86-1 (WRD/HD-88/212), 1987. 384p. Prepared in cooperation with the State of South Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for South Carolina consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 100 gaging stations, stage only at 7 gaging stations, stage and contents at 13 lakes and reservoirs, water quality at 47 gaging stations, and water levels at 40 observation wells. Also included are data for 38 crest-stage partial-record stations. Locations of these sites are shown. Additional water data were collected at various sites not part of the systematic data collection program. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in South Carolina. (See also W90-06515) (USGS)
W90-06516

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1987.
Geological Survey, Columbia, SC. Water Resources Div.
C. S. Bennett, R. D. Hayes, K. H. Jones, and T. W. Cooney.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-141360/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report SC-87-1 (WRD/HD-88/243), 1988. 483p. Prepared in cooperation with the State of South Carolina and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Carolina, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for South Carolina consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at gaging stations, stage only at 19 gaging stations, stage and contents at 12 lakes and reservoirs, water quality at 52 gaging stations, and water levels at 40 observation wells. Also included are data for 41 crest-stage partial-record stations and discharge measurement information at 5 locations. Locations of these sites are shown. Additional water data were collected at various sites not involved in the systematic data collection program. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in South Carolina. (See also W90-06517) (USGS)
W90-06517

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1986.
Geological Survey, Huron, SD. Water Resources Div.
E. B. Hoffman, R. D. Benson, and S. J. Lawrence.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-118575/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report SD-86-1 (WRD/HD-87/244), 1987. 347p. Prepared in cooperation with the State of South Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level. Water temperature.

Water resources data for the 1986 water year for South Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 110 streamflow-gaging stations; stage and contents records for 10 lakes and reservoirs, stage for 1 stream and 1 lake; water quality records for 30 stream-gaging stations, 3 wells, 5 ungaged streamsites, 4 lakes, 4 sewage lagoons, and 1 precipitation site; water levels for 31 wells; and precipitation records at 6 sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Dakota. (USGS)
W90-06518

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1987.
Geological Survey, Huron, SD. Water Resources Div.
E. B. Hoffman, R. D. Benson, and S. J. Lawrence.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-236344/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report SD-87-1 (WRD/HD-88/234), 1988. 307p. Prepared in cooperation with the State of South Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for South Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 114 streamflow-gaging stations; stage and contents records for 10 lakes and reservoirs, stage for 2 streams and 2 lakes; water quality records for 25 stream-gaging stations, 3 wells, 6 ungaged streamsites, 3 lakes, 1 sewage lagoon, and 1 precipitation site; water levels for 31 wells; and precipitation records at 9 sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Dakota. (See also W90-06518) (USGS)
W90-06519

WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1988.
Geological Survey, Huron, SD. Water Resources Div.
M. J. Burr, R. D. Benson, and D. S. Hansen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-216493/AS. Price codes: A14 in paper copy, A01 in microfiche. USGS Water-Data Report SD-88-1 (WRD/HD-89/263), 1989. 304p. Prepared in cooperation with the State of South Dakota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *South Dakota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for South Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 129 streamflow-gaging stations; stage and contents records for 10 lakes and reservoirs, stage for 3 streams and 3 lakes; water quality records for 16 streamflow-gaging stations, 3 daily-sediment stations; 3 wells, 4 ungaged streamsites, 1 lake, 1 sewage lagoon, and 1 precipitation site; water levels for 27 wells; and precipitation records at 4 sites. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperat-

ing State and Federal agencies in South Dakota. (See also W90-06519) (USGS)
W90-06520

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1986.
Geological Survey, Nashville, TN. Water Resources Div.
J. F. Lowery, P. H. Counts, H. L. Edmiston, and F. D. Edwards.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-228581/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report TN-86-1 (WRD/HD-87/225), 1987. 303p. Prepared in cooperation with the state of Tennessee and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Tennessee, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Tennessee consist of records of stage, discharge, and water quality of streams and springs; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of wells. This report contains discharge records for 96 gaging stations; stage only records for 2 lake-gaging stations; elevation and contents for 28 lakes and reservoirs; water quality for 43 stations and 45 wells; and water levels for 33 observation wells. Also included are 90 crest-stage partial-record stations and 78 low-flow partial-record stations. Additional water data were collected at various streams and spring sites not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Tennessee. (USGS)
W90-06521

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1987.
Geological Survey, Nashville, TN. Water Resources Div.
J. F. Lowery, P. H. Counts, H. L. Edmiston, and F. D. Edwards.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-242417/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report TN-87-1 (WRD/HD-88/225), 1988. 437p. Prepared in cooperation with the state of Tennessee and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Tennessee, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Tennessee consist of records of stage, discharge, and water quality of streams and springs; stage, contents, and water quality of lakes and reservoirs; water levels and water quality of wells; and quantity and quality of precipitation. This report contains discharge records for 100 gaging stations; stage only records for 6 gaging stations; elevation and contents for 27 lakes and reservoirs; water quality for 37 stations and 149 wells; water levels for 32 observation wells; and 1 precipitation station. Also included are 89 crest-stage partial-record stations and 82 low-flow partial-record stations. Additional water data were collected at various streams and spring sites not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Tennessee. (See also W90-06521) (USGS)
W90-06522

WATER RESOURCES DATA FOR TENNESSEE, WATER YEAR 1988.
Geological Survey, Nashville, TN. Water Resources Div.
J. F. Lowery, P. H. Counts, F. D. Edwards, and J. W. Garrett.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-106568/AS. Price codes: A17 in paper copy, A03 in microfiche. USGS Water-Data Report TN-88-1 (WRD/HD-89/258), 1989. 382p. Prepared in cooperation with the state of Tennessee and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Tennessee, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Tennessee consist of records of stage, discharge, and water quality of streams and springs; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of wells; and quantity and quality of precipitation. This report contains discharge records for 103 gaging stations; stage only records for 6 gaging stations; elevation and contents for 27 lakes and reservoirs; water quality for 41 stations and 32 wells; water levels for 32 observation wells; and 1 precipitation station. Also included are 92 crest-stage partial-record stations and 207 low-flow partial-record stations. Additional water data were collected at various streams and spring sites not involved in the systematic data collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Tennessee. (See also W90-06522) (USGS)
W90-06523

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1985. VOLUME 1; ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Houston, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-209367/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report TX-85-1 (WRD/HD-86-256), 1986. 463p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Arkansas River Basin, *Data collections, *Hydrologic data, *Neches River Basin, *Red River Basin, *Sabine River Basin, *Surface water, *Texas, *Trinity River Basin, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

The report series includes records of stage, discharge, and water quality of streams and canals, stage, contents, and water quality of lakes and reservoirs. Volume 1 contains records for water discharge at 139 gaging stations; stage only at 5 gaging station; stage and contents at 40 lakes and reservoirs; and water quality at 72 gaging stations. Also included are data for 13 partial-record stations. Additional water data were collected at 2 miscellaneous sites not involved in the systematic data-collection program. The data in this report represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating City, State, and Federal agencies in Texas. (See W90-06525 and W90-06526) (USGS)
W90-06524

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1985. VOLUME 2; SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-179800/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-85-2 (WRD/HD-86/257), 1986. 429p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06524 and W90-06526) (USGS)
W90-06525

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1985. VOLUME 3; COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-178224/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report TX-85-3 (WRD/HD-86/258), 1986. 447p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1985 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See also W90-06524 and W90-06525) (USGS)
W90-06526

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1986. VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-160817/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report TX-86-1 (WRD/HD-87/256), 1987. 463p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface-water data for the 1986 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06524, W900-06528, and W90-06529) (USGS)
W90-06527

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1986. VOLUME 2: SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-160825/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report TX-86-2 (WRD/HD-87/257), 1987. 413p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1986 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06527 and W90-06529) (USGS)
W90-06528

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1986. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-160833/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report TX-86-3 (WRD/HD-87/258), 1987. 405p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1986 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06527 and W90-06528) (USGS)
W90-06529

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1987. VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-113427/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report TX-87-1 (WRD/HD-88/256), 1988. 443p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface-water data for the 1987 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06527, W90-065431, and W90-06532) (USGS)
W90-06530

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1987. VOLUME 2: SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-113435/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-87-2 (WRD/HD-88/257), 1988. 419p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1987 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06530 and W90-06532) (USGS)
W90-06531

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1987. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, and H. J. Davidson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-113443/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-87-3 (WRD/HD-88/258), 1988. 417p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1987 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06530 and W90-06531) (USGS)
W90-06532

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1988: VOLUME 1: ARKANSAS RIVER, RED RIVER, SABINE RIVER, NECHES RIVER, TRINITY RIVER BASINS AND INTERVENING AND ADJACENT COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, H. J. Davidson, and W.J. Shelby.
Available from the National Technical Information Service, Springfield, VA 22161 as PB90-114380/AS. Price codes: A21 in paper copy, A03 in microfiche. USGS Water-Data Report TX-88-1 (WRD/HD-89/243), 1989. 467p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface-water data for the 1988 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in

Texas. (See W90-06530, W90-06534, and W90-06535) (USGS)
W90-06533

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1988. VOLUME 2: SAN JACINTO RIVER, BRAZOS RIVER, SAN BERNARD RIVER BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, H. J. Davidson, and W. J. Shelby.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-237309/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-88-2 (WRD/HD-89/244), 1989. 425p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1988 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06533 and W90-06535) (USGS)
W90-06534

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1988. VOLUME 3: COLORADO RIVER, LAVACA RIVER, GUADALUPE RIVER, NUECES RIVER, RIO GRANDE BASINS AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
H. D. Buckner, E. R. Carrillo, H. J. Davidson, and W. J. Shelby.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-237317/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report TX-88-3 (WRD/HD-89/245), 1989. 425p. Prepared in cooperation with the State of Texas and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Surface water, *Texas, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Surface water data for the 1988 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (See W90-06533 and W90-06534) (USGS)
W90-06535

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1986.
Geological Survey, Salt Lake City, UT. Water Resources Div.
M. D. ReMillard, L. R. Herbert, G. W. Sandberg, and G. A. Birdwell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-224341/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report UT-86-1 (WRD/HD-87/238), 1987. 404p. Prepared in cooperation with the State of Utah and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Utah, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Utah consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water quality of groundwater. This report contains discharge records for 209 gaging stations; stage and contents for 21 lakes and reservoirs; water quality for 25 hydrologic stations and 210 wells; miscellaneous temperature measurements and field determinations for 162 stations; and water levels for 33 observation wells. Additional water data were collected at various sites not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Utah. (See also W90-06477) (USGS)
W90-06536

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1987.
Geological Survey, Salt Lake City, UT. Water Resources Div.
M. D. ReMillard, L. R. Herbert, G. W. Sandberg, and G. A. Birdwell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-231303/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report UT-87-1 (WRD/HD-88/232), 1988. 367p. Prepared in cooperation with the State of Utah and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Utah, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Utah consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water quality of groundwater. This report contains discharge records for 180 gaging stations; stage and contents for 21 lakes and reservoirs; water quality for 22 hydrologic stations and 225 wells; miscellaneous temperature measurements and field determinations for 143 stations; and water levels for 32 observation wells. Additional water data were collected at various sites not involved of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Utah. (See also W90-06536) (USGS)
W90-06537

WATER RESOURCES DATA FOR UTAH, WATER YEAR 1988.
Geological Survey, Salt Lake City, UT. Water Resources Div.
M. D. ReMillard, L. R. Herbert, G. W. Sandberg, and G. A. Birdwell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-207633/AS. Price codes: A16 in paper copy, A01 in microfiche. USGS Water-Data Report UT-88-1 (WRD/HD-89/256), 1989. 364p. Prepared in cooperation with the State of Utah and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Utah, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Utah consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water quality of groundwater. This report contains discharge records for 178 gaging stations; stage and contents for 22 lakes and reservoirs; water quality for 20 hydrologic stations and 163 wells; miscellaneous temperature measurements and field determinations for 141 stations; and water levels for 31 observation wells. Additional water data were collected at various sites not involved of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Utah. (See also W90-06537) (USGS)
W90-06538

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1986.
Geological Survey, Richmond, VA. Water Resources Div.
B. J. Prugh, F. J. Easton, and D. D. Lynch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-101423. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report VA-86-1 (WRD/HD-87/247), 1987. 395p. Prepared in cooperation with the State of Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Virginia, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Virginia consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 189 gaging stations, stage only at 1 gaging station, stage and contents at 10 lakes and reservoirs, water quality at 41 gaging stations and 26 wells, and water levels at 63 observation wells. Also included are data for 78 crest-stage partial-record stations. Locations of these sites are shown. Miscellaneous hydrologic data were collected at 18 measuring sites not involved in the systematic data collection program. The data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Virginia. (See also W90-06261) (USGS)
W90-06539

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1987.
Geological Survey, Richmond, VA. Water Resources Div.
B. J. Prugh, F. J. Easton, and D. D. Lynch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-114375/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report VA-87-1 (WRD/HD-88/248), 1988. 441p. Prepared in cooperation with the State of Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Virginia, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Virginia consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels

and water quality of groundwater wells. This volume contains records for water discharge at 174 gaging stations, stage only at 1 gaging station, stage and contents at 10 lakes and reservoirs, water quality at 34 gaging stations and 45 wells, and water levels at 189 observation wells. Also included are data for 89 crest-stage partial-record stations. Locations of these sites are shown. Miscellaneous hydrologic data were collected at 44 measuring sites and 17 water quality sampling sites not involved in the systematic data collection program. The data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Virginia. (See also W90-06539) (USGS)
W90-06540

WATER RESOURCES DATA FOR VIRGINIA, WATER YEAR 1988.
Geological Survey, Richmond, VA. Water Resources Div.
B. J. Prugh, F. J. Easton, and D. D. Lynch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-207591/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report VA-88-1 (WRD/HD-89/255), 1989. 447p. Prepared in cooperation with the State of Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Virginia, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Virginia consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This volume contains records for water discharge at 170 gaging stations, stage only at 1 gaging station, stage and contents at 10 lakes and reservoirs, water quality at 38 gaging stations and 72 wells, and water levels at 207 observation wells. Also included are data for 92 crest-stage partial-record stations. Locations of these sites are shown. Miscellaneous hydrologic data were collected at 47 measuring sites and 23 water quality sampling sites not involved in the systematic data collection program. The data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Virginia. (See also W90-06540) (USGS)
W90-06541

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1984.
Geological Survey, Tacoma, WA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-236302/AS. Price codes: A20 in paper copy, A01 in microfiche. USGS Water-Data Report WA-84-1 (WRD/HD-86/260), 1986. 427p. Prepared in cooperation with the State of Washington and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Washington, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1984 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality of wells and springs. This report contains discharge records for 196 gaging stations; stage only records for 4 gaging stations; stage and contents for 41 lakes and reservoirs; water quality for 42 gaging stations; and water levels for 121 observation wells. Also included are data for 14 crest-stage partial-record stations. Locations of these sites are shown. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Washington. (See also W90-06264) (USGS)
W90-06542

WATER RESOURCES DATA FOR WASHINGTON, WATER YEAR 1986.
Geological Survey, Tacoma, WA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-246889/AS. Price codes: A23 in paper copy, A01 in microfiche. USGS Water-Data Report WA-86-1 (WRD/HD-88/235), 1988. 517p. Prepared in cooperation with the State of Washington and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Washington, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Washington consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels of wells. This report contains discharge records for 215 gaging stations; stage only records for 7 gaging stations; stage and contents for 38 lakes and reservoirs; water quality for 38 streamflow-gaging stations and 9 ungaged streamsites; and water levels for 75 observation wells. Also included are data for 15 crest-stage partial-record stations and 355 partial-record or miscellaneous streamflow stations. Locations of these sites are shown. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Washington. (See also W90-06542) (USGS)
W90-06543

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1985.
Geological Survey, Charleston, WV. Water Resources Div.
W. N. Embree, E. A. Friel, and F. M. Taylor.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-224879/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report WV-85-1 (WRD/HD-87/224), 1987. 224p. Prepared in cooperation with the State of West Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *West Virginia, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for West Virginia consist of records of stage, discharge, and water quality of streams; contents of reservoirs; and water levels and water quality of observation wells. This report contains: (1) Discharge records for 75 streamflow-gaging stations; stage only records for 12 gaging stations, and 2 crest-stage partial-record stations; (2) Contents for 2 reservoirs, and change in contents for 1 reservoir; (3) Water quality records for 24 streamflow-gaging stations; (4) Water level records for 33 observation wells; and (5) Water quality records for 17 observation wells. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in West Virginia. (See also W90-06265) (USGS)
W90-06544

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1986.
Geological Survey, Charleston, WV. Water Resources Div.
S. M. Ward, E. A. Friel, F. M. Taylor, and G. M. Ferrell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-236310/AS. Price codes: A10 in paper copy, A01 in microfiche. USGS Water-Data Report WV-86-1 (WRD/HD-88/237), 1988. 196p. Prepared in cooperation with the State of West Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *West Virginia, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for West Virginia consist of records of stage, discharge, and water quality of streams; contents of reservoirs; and water levels of observation wells. This report contains: (1) Discharge records for 79 streamflow-gaging stations; stage only records for 12 gaging stations, and 2 crest-stage partial-record stations; (2) Contents for 1 reservoir, and change in contents for 1 reservoir; (3) Water quality records for 20 streamflow-gaging stations; and (4) Water level records for 33 observation wells. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in West Virginia. (See also W90-06544) (USGS)
W90-06545

WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1987.
Geological Survey, Charleston, WV. Water Resources Div.
S. M. Ward, W. A. Hobba, F. M. Taylor, and G. M. Ferrell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-223994/AS. Price codes: A11 in paper copy, A01 in microfiche. USGS Water-Data Report WV-87-1 (WRD/HD-89/271), 1989. 228p. Prepared in cooperation with the State of West Virginia and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *West Virginia, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for West Virginia consist of records of stage, discharge, and water quality of streams; contents of reservoirs; and water levels of observation wells. This report contains: (1) Discharge records for 83 streamflow-gaging stations; stage only records for 7 gaging stations, and 2 crest-stage partial-record stations; (2) Contents for 1 reservoir, and change in contents for 1 reservoir; (3) Water quality records for 20 streamflow-gaging stations; and (4) Water level records for 34 observation wells. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in West Virginia. (See also W90-06545) (USGS)
W90-06546

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1986.
Geological Survey, Madison, WI. Water Resources Div.
B. K. Holmstrom, P. A. Kammerer, and R. M. Erickson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-102678/

AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report WI-86-1 (WRD/HD-87/253), 1987. 402p. Prepared in cooperation with the State of Wisconsin and with other agencies.

Descriptors: *Acid rain, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wisconsin, Chemical analysis, Flow rates, Gaging stations, Lakes, Microbiological studies, Sediments, Water level.

Water resources data for the 1986 water year for Wisconsin include records of streamflow at gaging stations, partial-record stations, and miscellaneous sites; records of chemical, biological, and physical characteristics of surface and groundwater. Records of chemical analysis of precipitation, surface and groundwater associated with acid deposition are included. In addition water levels in observation wells are reported. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Wisconsin. (See also W90-06266) (USGS)
W90-06547

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1987.
Geological Survey, Madison, WI. Water Resources Div.
B. K. Holmstrom, P. A. Kammerer, and R. M. Erickson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-130801/AS. Price codes: A17 in paper copy, A01 in microfiche. USGS Water-Data Report WI-87-1 (WRD/HD-88/279), 1988. 367p. Prepared in cooperation with the State of Wisconsin and with other agencies.

Descriptors: *Acid rain, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wisconsin, Chemical analysis, Flow rates, Gaging stations, Lakes, Microbiological studies, Sediments, Water level.

Water resources data for the 1987 water year for Wisconsin include records of streamflow at gaging stations, partial-record stations, and miscellaneous sites; records of chemical, biological, and physical characteristics of surface water and groundwater. Records of chemical analysis of precipitation, surface water and groundwater associated with acid deposition are included. In addition water levels in observation wells are reported. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Wisconsin. (See also W90-06547) (USGS)
W90-06548

WATER RESOURCES DATA FOR WISCONSIN, WATER YEAR 1988.
Geological Survey, Madison, WI. Water Resources Div.
B. K. Holmstrom, P. A. Kammerer, and R. M. Erickson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-224695/AS. Price codes: A19 in paper copy, A01 in microfiche. USGS Water-Data Report WI-88-1 (WRD/HD-89/264), 1989. 429p. Prepared in cooperation with the State of Wisconsin and with other agencies.

Descriptors: *Acid rain, *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wisconsin, Chemical analysis, Flow rates, Gaging stations, Lakes, Microbiological studies, Sediments, Water level.

Water resources data for the 1988 water year for Wisconsin include records of streamflow at gaging stations, partial-record stations, and miscellaneous sites; records of chemical, biological, and physical characteristics of surface water and groundwater. Records of chemical analysis of precipitation, surface water and groundwater associated with acid deposition are included. In addition water levels in observation wells are reported. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Wisconsin. (See also W90-06548) (USGS)
W90-06549

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1985.
Geological Survey, Cheyenne, WY. Water Resources Div.
S. A. Druse, and S. J. Rucker.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-172565/AS. Price codes: A22 in paper copy, A01 in microfiche. USGS Water-Data Report WY-85-1 (WRD/HD-86/243), 1986. 499p. Prepared in cooperation with the State of Wyoming and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wyoming, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Wyoming consist of records of stage, discharge and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 187 gaging stations; stage and contents for 15 lakes and reservoirs; water quality for 78 gaging stations, and 73 ungaged stations; and water levels for 5 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Wyoming. (See also W90-06267) (USGS)
W90-06550

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1986.
Geological Survey, Cheyenne, WY. Water Resources Div.
S. A. Druse, W. R. Glass, P. B. McCollam, and H. I. Kennedy.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-231056/AS. Price codes: A21 in paper copy, A01 in microfiche. USGS Water-Data Report WY-86-1 (WRD/HD-87/239), 1987. 474p. Prepared in cooperation with the State of Wyoming and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wyoming, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1986 water year for Wyoming consist of records of stage, discharge and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 195 gaging stations; stage and contents for 15 lakes and reservoirs; water quality for 79 gaging stations, and 69 ungaged stations; and water levels for 5 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Wyoming. (See also W90-06550)
W90-06551

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1987.
Geological Survey, Cheyenne, WY. Water Resources Div.
S. A. Druse, W. R. Glass, P. B. McCollam, and D. A. Peterson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-240338/AS. Price codes: A18 in paper copy, A01 in microfiche. USGS Water-Data Report WY-87-1 (WRD/HD-88/240), 1988. 396p. Prepared in cooperation with the State of Wyoming and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wyoming, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Wyoming consist of records of stage, discharge and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 172 gaging stations; stage and contents for 16 lakes and reservoirs; water quality for 67 gaging stations, and 52 ungaged stations; and water levels for 5 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Wyoming. (See also W90-06551) (USGS)
W90-06552

WATER RESOURCES DATA FOR WYOMING, WATER YEAR 1988.
Geological Survey, Cheyenne, WY. Water Resources Div.
S. A. Druse, W. R. Glass, P. B. McCollam, and D. A. Peterson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB89-194955/AS. Price codes: A23 in paper copy, A01 in microfiche. USGS Water-Data Report WY-88-1 (WRD/HD-89/240), 1989. 518p. Prepared in cooperation with the State of Wyoming and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Surface water, *Water quality, *Wyoming, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for Wyoming consists of records of stage, discharge and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality of groundwater. This report contains discharge records for 177 gaging stations; stage and contents for 16 lakes and reservoirs; water quality for 66 gaging stations, and 43 ungaged stations; and water levels for 5 observation wells. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Wyoming. (See also W90-06552) (USGS)
W90-06553

WATER RESOURCES DATA FOR IOWA, WATER YEAR 1985.
Geological Survey, Iowa City, IA. Water Resources Div.
N. B. Melcher, M. G. Detroy, W. J. Matthes, and R. E. Hansen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB87-111886/AS. Price codes: A15 in paper copy, A01 in microfiche. USGS Water-Data Report IA-85-1 (WRD/HD-86-237), 1986. 332p. Prepared in cooperation with the State of Iowa and other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Iowa, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Groundwater level, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Water analysis, Water level, Water temperature.

Water resources data for the 1985 water year for Iowa consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; groundwater levels and groundwater quality. This report contains discharge records for 111 stream-gaging stations, stage and contents for 8 lakes and reservoirs, water quality for 8 stream-gaging stations, sediment records for 12 stream-gaging stations; water levels for 94 observation wells; and chemical analysis for 214 observation wells. Also included are 118 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State and Federal agencies in Iowa. (USGS)
W90-06554

8. ENGINEERING WORKS

8A. Structures

EFFECTS OF HYETOGRAPH SHAPE ON DETENTION POND SIZING.
Dominion Engineering Resources, Newport News, VA.
For primary bibliographic entry see Field 2E.
W90-05626

APPLICATIONS OF THE MANNING'S AND RATIONAL FORMULAS FOR THE DESIGN OF STORM DRAINS IN SINGAPORE.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 2E.
W90-05646

DESIGN OF STORMWATER DETENTION BASINS. A SIMPLIFIED METHOD.
Rettew Associates, Inc., Lancaster, PA.
For primary bibliographic entry see Field 2E.
W90-05648

PAVEMENT DRAINAGE DESIGN USING YEN AND CHOW RAINFALL.
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-05653

FLOW BEHAVIORS IN HEADRACE TUNNEL OF RUN-OF-THE-RIVER POWER STATIONS.
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05693

CHIEF JOSEPH DAM, COLUMBIA RIVER, WASHINGTON, ADDITIONAL UNITS AND STRUCTURAL MODIFICATION FOUNDATION REPORT.
Army Engineer District, Seattle, WA. Seattle District.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-685. Price codes: A10 in paper copy, A01 in microfiche. Final report, 1988. 263p, 13 fig, 5 tab, 23 plates, 8 ref, 4 append.

Descriptors: *Chief Joseph Dam, *Hydraulic structures, *Dam foundations, *Dams, *Washington, Construction, Spillways, Intakes, Instrumentation, Design criteria, Concrete dams.

Chief Joseph Dam is located on the Columbia River in north central Washington, 545 river miles above its mouth and 51 river miles below Grand Coulee Dam. In order to produce additional power, construction of structural modifications to raise the pool elevation 10 feet and install 11 additional generating units was started in 1974 and was completed in 1980. Raising the pool to elevation 956 feet occurred in February 1981. The structural modification consisted of raising the dam 10 feet (including the spillway monoliths, nonoverflow sections, and intake structure); removal and rebuilding of the spillway piers; new gate installation; and adding additional concrete mass to insure stability of the gravity structures with the higher reservoir. This report was prepared to ensure the preservation for future use of complete records of foundation conditions encountered during construction and methods used to adapt structures to these conditions. The final foundation conditions and treatment for the additional powerhouse units; post construction instrumentation, drain hole drilling and rock contour maps for the spillway, nonoverflow, intake and closure monoliths; and the left and right abutment exploration and instrumentation programs are documented. (Lantz-PTT)
W90-05740

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 3: LOWER SANTA ANA RIVER, APPENDIXES.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-543. Price codes: A99 in paper copy, A01 in microfiche. August 1988. 572p, 7 fig, 11 tab, 39 plates, 52 ref, append.

Descriptors: *California, *Dams, *Channeling, *Hydraulic structures, *Santa Ana River, *Geohydrology, *Geology, Santiago Creek, Geologic fractures, Foundation rocks.

Geotechnical investigations were conducted to determine and evaluate the topography, geology, and groundwater and foundation conditions of the Lower Santa Ana River. This appendix provides a description of the project area; the geology, faulting and seismicity; groundwater conditions; the geotechnical explorations and testing performed; presents the existing foundation conditions; and parameters used in the project design. Recommendations are given for foundation treatment, embankment design, subdrainage systems, disposal site compatibility, and construction applications. The channelization measures for the Lower Santa Ana River discussed in this report extend approximately 23 miles through the northwestern portion of Orange County, California. The project begins at Weir Canyon Road and ends at the Pacific Ocean between Huntington and Newport Beaches. Localized improvements are also proposed within Santa Ana Canyon, immediately below Prado Dam. (See also W90-05762) (Lantz-PTT)
W90-05757

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 1: SEVEN OAKS DAM INCLUDING APPENDIX A.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-540. Price codes: A99 in paper copy, A01 in microfiche. August 1988. 822p, 12 fig, 16 tab, 35 plates, 22 ref, 7 append.

Descriptors: *Dams, *California, *Earth dams, *Hydraulic structures, *Santa Ana River, Seven Oaks Dam, Santiago Creek, Costs, Dam construction, Spillways.

This volume contains the general design for the Seven Oaks Dam and the preliminary floodplain and floodway delineation between Seven Oaks Dam and Prado Reservoir. Seven Oaks Dam, located 8 miles northeast of the city of Redlands in San Bernardino County, California will be an earth and fill structure with a height of 550 ft above the existing streambed, crest width of 40 ft, crest length of 2,980 ft and crest elevation at 2,610 ft. The upstream and downstream slopes will be 1 vertical on 2 horizontal. The dam will have a storage capacity of 145,600 acre-ft at the spillway crest elevation of 2,580 ft. A detached spillway will be located about 1,700 ft east of the dam. It will have a trapezoidal cross-section with a base width of 500 ft and sideslopes averaging 1 vertical on 1 horizontal. The spillway will be about 1,400 ft long and unlined except for a concrete control sill at the crest, approximately 1,000 ft from the downstream end. The outlet works tunnel will be located within the east abutment. The tunnel, excavated in rock and lined with reinforced concrete, will be approximately 1,750 ft long. Total first cost of the project is estimated at $316,283,000. (See W90-05759 thru W90-05762) (Lantz-PTT)
W90-05758

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 7: HYDROLOGY.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-547. Price codes: A10 in paper copy, A01 in microfiche. August 1988. 223p, 41 tab, 77 plates.

Descriptors: *Dams, *California, *Hydraulic structures, *Santa Ana River, *Flood control, Dams, Seven Oaks Dam, Santiago Creek, Reservoirs.

This volume of the Phase II General Design Memorandum (GDM) presents the results of hydrologic investigations made for the Santa Ana River Project in connection with flood control planning and design efforts not covered in the 1975 Review Report, the 1980 Phase I GDM, or the 1985 Supplement to the Phase I GDM, plus updating for changed conditions and new information. Primary emphasis was placed on studies concerned with recommended project elements for flood control on Seven Oaks Dam (previously known as Upper Santa Ana River Dam), Prado Dam, Mill Creek Levees, Oak Street Drain, Santiago Creek, and lower Santa Ana River, and how the reservoir system will operate. (See also W90-05757, W90-05758, W90-05760, W90-05761 and W90-05762) (Lantz-PTT)
W90-05759

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 5: OAK STREET DRAIN.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-546. Price codes: A10 in paper copy, A01 in microfiche. August 1988. 174p, 13 fig, 10 tab, 19 plates, 2 append.

Descriptors: *Dams, *California, *Flood control, *Hydraulic structures, *Santa Ana River, Santiago Creek, Channels, Economic aspects.

This volume accompanies the Main Report and Supplemental Environmental Impact Statement for the Phase II General Design Memorandum for the Santa Ana River Mainstem including Santiago Creek and contains the general design for the Oak Street Drain. The recommended plan for Oak Street Drain consists of a concrete channel beginning at the existing Oak Street debris basin and extending over 3 miles to the confluence with Temescal Wash. The channel is designed to provide 100-year level of protection. Total project first cost is estimated at $20,652,000. (See W90-05757 thru W90-05759, W90-05761 and W90-05762) (Lantz-PTT)
W90-05760

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 4: MILL CREEK LEVEE.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-545. Price codes: A06 in paper copy, A01 in microfiche. August 1988. 108p, 9 fig, 18 tab, 31 plates, 11 ref.

Descriptors: *California, *Flood control, *Santa Ana River, *Prado Dam, *Hydraulic structures, *Levees, Santiago Creek, Mill Creek, Floodwall, Vegetation, Bank stabilization, Costs.

This volume accompanies the Main Report and Supplemental Environmental Impact Statement for the Phase II General Design Memorandum for the Santa Ana River Mainstem including Santiago

Creek and contains the general design for the Mill Creek Levee. The recommended flood control plan for the Mill Creek levee consists of raising a portion of the existing levee from stations 70+00 to 88+70, extending the toe protection from stations 70+00 to 129+33.33 and from stations 130+72 to 196+25.37, and constructing a floodwall along the top of the levee from stations 70+00 to 130+20 and from stations 130+72 to 196+25.37. Esthetic treatment will consist of groupings of native trees and large shrubs planted along the landward side of the embankment. Total first cost for this element of the Santa Ana River Mainstem project is estimated at $5,109,000. (See W90-05757 thru W90-05760 and W90-05762) (Lantz-PTT)
W90-05761

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 3: LOWER SANTA ANA RIVER (PRADO DAM TO PACIFIC OCEAN).
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A204-544. Price codes: A18 in paper copy, A01 in microfiche. August 1988. 256p, 7 fig, 28 tab, 108 plates, 8 photos, 5 ref, 5 append.

Descriptors: *Channeling, *Flood control, *California, *Channel stability, *Santa Ana River, *Prado Dam, *Hydraulic structures, Design standards, Environmental policy, Overflows, Riprap, Channel flow, Costs, Santiago Creek.

This volume accompanies the Main Report and Supplemental Environmental Impact Statement for the Phase II General Design Memorandum for the Santa Ana River Mainstem including Santiago Creek and contains the general design for the Santa Ana River from Prado Dam to the Pacific Ocean. The recommended plan will convey design outflows of 30,000 cu ft/sec from Prado Dam to 47,000 cu ft/sec at the Pacific Ocean. The project consists of acquisition of the post project overflow area along 8 miles of river just downstream of Prado Dam (Prado Dam to Weir Canyon Road) and 23 miles of improved channel (Weir Canyon to the Ocean). The reach from Prado Dam to Weir Canyon would remain in a natural rural condition for wildlife and open space value. The improved channel will consist of sections of trapezoidal riprap or grouted riprap channel, trapezoidal concrete-lined channel and rectangular concrete-lined channel. The ocean outlet will consist of rock mounded jetties. In addition, the Greenville-Banning Channel would be modified to join the Santa Ana River about 1 mile upstream of the Pacific Ocean. Talbert Channel will be relocated 1,000 ft upcoast from its present location to accommodate widening of the Santa Ana River at the ocean. The channel access and maintenance roads would be incorporated into the overall recreational trail system for the entire river. A 92-acre marsh will be restored at the mouth of the river for the preservation and enhancement of wildlife. The estimated total project first cost is $365,000,000 including preconstruction engineering and design. Average annual charges will include $595,000 for channel operation and maintenance and $50,000 for recreational maintenance. (See W90-05758 thru W90-05761) (Lantz-PTT)
W90-05762

GROUND-WATER MONITORING COMPLIANCE PROJECTS FOR HANFORD SITE FACILITIES: PROGRESS REPORT FOR THE PERIOD JANUARY 1 TO MARCH 31, 1988. VOLUME 4--APPENDIX A.
Battelle Pacific Northwest Labs., Richland, WA.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-017370. Price codes: A99 in paper copy, A01 in microfiche. Report No. PNL---6581-Vol. 4, May 1988. 728p. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Groundwater pollution, *Radioactive wastes, *Hanford Site, *Washington, *Monitoring, *Data collections, *Wells, Groundwater quality, Well construction, Washington, Well logs, Drillers logs.

This Inspection Plan identifies the inspections required and the responsible people to perform the inspections of the monitoring wells to be constructed under Project B-678. The inspection of well construction activities is intended to provide assurance that the work performed by construction forces is in accordance with the approved contract documents. The degree of inspection is commensurate with the significance of the monitoring wells with regard to function and safety. (Lantz-PTT)
W90-05766

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 2: PRADO DAM.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-542. Price codes: A99 in paper copy, A01 in microfiche. August 1988. 591p, 7 fig, 10 tab, 22 plates, 4 append.

Descriptors: *California, *Dams, *Flood control, *Prado Dam, *Santa Ana River, Costs, Dikes, Hydraulic structures, Reservoirs, Santiago Creek, Spillways.

Recommended improvement to the existing flood control Prado Dam on the Santa Ana River in California which was completed by Corps of Engineers in 1941, consists of enlarging the reservoir capacity by raising the spillway crest 20 ft and the top of the dam 28.4 ft, to elevations 563 ft and 594.4 ft, respectively. A new gated outlet structure capable of releasing 30,000 cu ft/sec, an auxiliary dike, and a dike along the Corona Expressway would be provided. Approximately 1,660 acres of land up to elevation 566 ft would be required for the enlarged reservoir. Interior dikes would be provided for the protection of the existing facilities at the Corona Sewage Treatment Plant, Alcoa Aluminum Plant, Corona Housing Tract, and California Institution for Women. The cost for the recommended improvement is estimated at $212,623,000, including $116,274,000 for land acquisition. (See W90-05804 thru W90-05805) (Author's abstract)
W90-05803

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. MAIN REPORT AND SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-539. Price codes: A99 in paper copy, A01 in microfiche. August 1988. 558p, 23 fig, 13 tab.

Descriptors: *California, *Dam design, *Environmental effects, *Environmental impact statement, *Flood control, *Santa Ana River, *Water resources development, *Water resources management, Endangered species, Flood channels, Flood protection, Wetlands.

This Santa Ana River Mainstem project is designed to provide urban flood protection to the growing communities in Orange, Riverside, and San Bernardino counties. The project will provide various levels of flood protection ranging from 100-yr to 190-yr in areas most susceptible to damages from floodflows for over 2 million people and businesses within the three-county area. Most of the development is in the Lower Santa Ana River Basin (Orange County). The project will provide environmental enhancement in a currently degraded marsh area at the mouth the Santa Ana River, thereby providing significant value as a wetland habitat for migrating waterfowl and for the California least tern, a federally listed endangered species. The recommended plan consists of the following elements on the Santa Ana River Mainstem: (1) construction of Seven Oaks Dam in the upper Santa Ana Canyon to control a 350-yr flood event at the damsite; (2) delineation of the 100-yr floodway and floodway fringe for the 35-mile reach between Seven Oaks Dam and Prado Dam, with local authorities managing this area in accordance with guidelines established by the Federal Emergency Management Agency (FEMA); (3) modifications to the existing Federal flood control levees at Mill Creek to restore their original Standard Project Flood (SPF) level of protection; (4) construction of a 100-yr level of protection channel on the Oak Street Drain in the City of Corona; (5) modifications to the existing Prado Dam to provide a 190-yr level of protection; (6) channel improvements to provide a 100-yr level flood protection along Santiago Creek in Orange County; (7) construction of the Lower Santa Ana River Channel to provide 190-yr level flood protection; and (8) enhancement of 84 acres of marshland at the mouth of the Santa Ana River for the endangered species plus restoration of 8 acres of marshland for mitigation of wildlife habitat. (See also W90-05803 and W90-05805) (Lantz-PTT)
W90-05804

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 1: SEVEN OAKS DAM, APPENDIXES B THROUGH G.
Army Engineer District, Los Angeles, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-541. Price codes: A99 in paper copy, A01 in microfiche. August 1988. 682p, 39 fig, 39 tab, 33 plates.

Descriptors: *California, *Dam design, *Environmental effects, *Environmental impact statement, *Flood control, *Santa Ana River, *Seven Oaks Dam, *Water resources management, Flood channels, Flood protection.

The Santa Ana River Mainstem project is designed to provide urban flood protection to the growing communities in Orange, Riverside, and San Bernardino counties. The project will provide various levels of flood protection ranging from 100-yr to 190-yr in areas most susceptible to damages from floodflows for over 2 million people and businesses within the three-county area. One of the recommendations is the construction of Seven Oaks Dam in the upper Santa Ana Canyon to control a 350-yr flood event at the damsite. General design information relating to the Seven Oaks Outlet Works are presented. (See W90-05803 thru W90-05804) (Lantz-PTT)
W90-05805

FIELD MEASUREMENTS OF DIRECTIONAL WAVE LOADS ON COASTAL STRUCTURES.
Rijkswaterstaat, Delft (Netherlands). Road and Hydraulic Engineering Div.
For primary bibliographic entry see Field 8B.
W90-05858

USING SUPERCOMPUTERS FOR THE TIME HISTORY ANALYSIS OF OLD GRAVITY DAMS.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Wasserbau und Wasserwirtschaft und Inst. fuer Wasserbau.
G. Rouve, and A. Peters.
Advances in Water Resources AWREDI, Vol. 12, No. 2, p 79-83, June 1989. 6 fig, 6 ref.

Descriptors: *Computers, *Dam stability, *Dams, *Finite element method, *Gravity dams, *Risk assessment, Computer models, Deterioration, Hydraulic structures, Percolation, Temperature effects, Weathering.

Some of the old masonry dams that were built in West Germany at the beginning of this century are a matter of concern today. Over time, the effects of aging include weathering, deterioration at the downstream and upstream dam faces, wet areas at the downstream face, loosening of the upstream facing, cracks due to temperature changes, and increased percolation of water through the dam. The Finite Element Method offers a suitable tool to evaluate the safety of the old gravity dams. The model itself consists of three finite element models coupled together to compute seepage, temperature distribution, and tensions and displacements. The reliability of the results strongly depends on knowledge of the material parameters. Using historical records and observations a numerical back-

analysis model has been developed to simulate the behavior of these old masonry structures and to estimate their material properties by calibration. Only an implementation on a fourth generation vector computer made the application for this large model possible in practice. (Tappert-PTT)
W90-05886

TURNKEY WELL, RESERVOIR, AND PUMP STATION IN AN ARID REGION.
Engineering-Science, Inc., Phoenix, AZ.
For primary bibliographic entry see Field 5F.
W90-05893

SUBSTANTIATION OF THE TIERED TECHNOLOGY OF CONSTRUCTING ARCH DAMS.
For primary bibliographic entry see Field 8F.
W90-06124

REGULATION OF THE TEMPERATURE REGIME OF CONCRETE IN THE TIERED TECHNOLOGY OF CONSTRUCTING AN ARCH DAM.
For primary bibliographic entry see Field 8F.
W90-06125

REINFORCED-CONCRETE PANELS FOR FORMING GROUT JOINTS AS AN ELEMENT OF TIERED TECHNOLOGY.
For primary bibliographic entry see Field 8F.
W90-06126

CHARACTERISTICS OF THE CONSTRUCTION OF ARCH DAMS ON THE SULAK RIVER.
For primary bibliographic entry see Field 8F.
W90-06129

IMPROVEMENT OF BULKHEAD-TYPE STRUCTURES.
O. N. Chebotarev, R. M. Erlikh, and Y. N. Feldman.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 161-162, March 1989. 1 fig, 1 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 37, March, 1989.

Descriptors: *Bulkheads, *Construction materials, *Construction methods, *Hydraulic structures, Costs, Design criteria, Sheet piling.

One of the problems encountered in construction is obtaining the necessary supplies. Due to a shortage of sheet piling and the need to complete the bulkhead designed, constructing a wall from single-row Larsen-5 sheet piling reinforced with R-50 rails was considered. To determine the effectiveness of the proposed substitution, the ratio of the moment being absorbed by the wall to its mass was derived. The index for the design solution was 265 and for the proposed one 506. In order to test the structure a section pile of Larsen-5 sheet piling with a length of 27 m with a 15-m-long R-50 rail welded to it was investigated. The tests were conducted according to the scheme of a single-span beam with a 16-m span and two cantilevers, each 5.5 m. The pile was driven in two stages by a point load located in the central part of the span. After each driving the elements of the sectional pile were thoroughly inspected. Cracks were not found in the sheet piling, rail, and welds. In the second stage plastic deformation occurred. By strengthening the sheet piles with two rails, the resisting moment of the wall was equal to 7831 cu cm. The moment being absorbed by the wall was 3030 kNm, and the index of effectiveness was 580. The economic cost of introducing the described technological solution on the wharf with a depth of 11 m and length of 80 m was 24,000 rubles, and the annual cost from introducing this solution in two ports on the Black Sea basin was 127,000 rubles. It was determined that reinforcing sheet piling by welding rails (used ones) was acceptable in hydrotechnical construction. (White-Reimer-PTT)
W90-06132

FURTHER DEVELOPMENT OF THE THEORY OF RELIABILITY OF HYDRAULIC STRUCTURES.
T. E. Mirtskhulava.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 163-167, March 1989. 15 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 39-41, March, 1989.

Descriptors: *Hydraulic design, *Hydraulic engineering, *Hydraulic structures, *Reliability, Model studies, Probabilistic process, Project planning.

Despite great progress made in the design and construction of hydraulic structures, problems develop in their operation too frequently. In order to improve the reliability of these structures, research has been conducted to predict their performance. Recent investigations and research have developed methods to calculate the reliability of: parts of structures subjected to eroding, seepage, and other effects of water; slopes, embankments, flumes, canals, and covered pipelines, settling basins and linings, pumping stations; and dams, drainage systems, and large canals. At this time the inability to construct reliable hydrotechnical projects and systems is not due to a lack of scientific and technical information, but to an absence of standards and implementation of new concepts. The introduction of reliability theory would take into account the nature and characteristics of hydraulic structures, and model so-called aging systems taking into account the time of effect and cyclical nature of processes. Deterministic calculations would be carried out, but the calculated parameter values would be selected by probabilistic-optimization standardization. This method can be considered one of the first steps for a gradual conversion of the present standards with a 'semiprobabilistic' approach to the next generation of standards based on a probabilistic-economic approach. Improvement of deterministic relations should be regarded as one of the first steps forward in creating general methods from the standpoint of reliability theory. (White-Reimer-PTT)
W90-06133

SPALL REPAIR OF WET CONCRETE SURFACES.
Singleton Materials Engineering Labs., Knoxville, TN.
For primary bibliographic entry see Field 8F.
W90-06219

8B. Hydraulics

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON CHANNEL FLOW AND CATCHMENT RUNOFF: CENTENNIAL OF MANNING'S FORMULA AND KUICHLING'S RATIONAL FORMULA.
For primary bibliographic entry see Field 2E.
W90-05621

RELATIVE VELOCITY IN A PARTIALLY FULL PIPE.
Colorado Univ. at Denver. Dept. of Civil Engineering.
W. C. Hughes.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 325-330, 3 fig, 2 tab, 5 ref.

Descriptors: *Flow resistance, *Conveyance structures, *Hydraulics, *Hydraulic roughness, *Pipe flow, *Flow velocity, Water transport, Mannings equation, Mathematical studies, Channel flow, Flow characteristics, Velocity, Roughness coefficient.

An equation was developed to compute the velocity in a partially full circular conduit based on full flow conduit properties. It incorporates the results of empirical studies showing that the velocity in a partially full conduit is a function of wall roughness as well as relative depth. The equation is valid for pipes within a Manning coefficient range of 0.009 to 0.013. Pipe materials studied included polyvinyl chloride, concrete, clay/concrete, concrete, and asbestos cement. When compared with the conventional constant n relative velocity curve, velocity predictions with the newly developed equation were substantially better with smooth polyvinyl chloride pipe (4.2% vs. 18.4% deviation from observed values), slightly better with asbestos cement pipe (14.9% vs. 18.1% deviation), and no different with concrete pipe (13.5% deviation for both). (See also W90-05621) (Cassar-PTT)
W90-05658

PREDICTING STREAM VELOCITIES IN A NAVIGATION CHANNEL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
C. Y. Kuo.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 331-339, 8 fig, 3 ref.

Descriptors: *Hydraulics, *Flow velocity, *Navigable waters, *Channel flow, *Streamflow, Hydraulic roughness, Roughness coefficient, Mannings equation, Chezy equation, Hydraulic friction, Kanawha River, West Virginia, Mathematical studies, Velocity, Friction.

A procedure was developed to perform hydrologic and hydraulic analysis in order to predict streamflows, cross-sectional mean velocities, mean velocities in subsections within a cross section, and point velocities. Both Manning's equation and the Chezy's equation were used to study channel roughness and calculate velocities. Field experiments were conducted at a selected river section of a navigation channel, Marmet Locks on the Kanawha River, West Virginia. Comparisons of the calculated and measured point velocities for different flow conditions showed very good agreement, indicating that the procedures used to predict point velocities and mean velocities were adequate.(See also W90-05621) (Author's abstract)
W90-05659

MANNING'S EQUATION AND VELOCITY DISTRIBUTION IN OPEN CHANNELS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-05660

MANNING'S EQUATION AND VELOCITY DISTRIBUTION IN OPEN CHANNELS.
Pittsburgh Univ., PA. Dept. of Civil Engineering.
C.-L. Chiu, and J.-D. Chiou.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 340-349, 3 fig, 7 ref.

Descriptors: *Hydraulics, *Streamflow, *Mannings equation, *Flow velocity, *Channel flow, *Flow, *Channel morphology, Velocity distribution, Open-channel flow, Mathematical studies, Hydraulic radius, Slopes, Cross-sections, Roughness coefficient, Hydraulic roughness.

A velocity distribution equation was developed from the probability and entropy concepts to establish a linkage between the mean velocity obtained from the Manning's equation and the corresponding velocity distribution in a channel cross section. The equation was useful in computing the velocity distribution and the mean velocity from simple inputs such as Manning's n, hydraulic radius, and channel slope. Two examples were given: one was a wide channel, one was a nonwide channel. (See also W90-05621) (Cassar-PTT)
W90-05660

DIRECT APPLICABILITY OF THE CHEZY FORMULA TO NATURAL CHANNELS.
Polish Academy of Sciences, Warsaw. Inst. of

Geophysics.
W. G. Strupczewski, and R. Szymkiewicz.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 350-361, 9 fig, 3 ref.

Descriptors: *Hydraulics, *Streamflow, *Channel flow, *Chezy equation, *Flow, *Channel morphology, Mannings equation, Cross-sections, Mathematical studies, Hydraulic radius, Hydraulic friction, Friction, Hydraulic roughness, Roughness coefficient.

The Chezy formula with constant roughness was applied to a symmetric uniform channel with constant surface friction. Cross-section profiles were derived which satisfy certain conditions imposed on a stage-discharge rating curve. For a given initial shape of the channel, an equation for a profile above the initial level was derived, and the effect of change in geometric patterns was investigated. The following conditions were considered: (1) constant value of the ratio of kinematic wave speed to the average velocity of flow above initial levels, (2) discharge equalling 1, resulting from vertical walls with the Manning friction above the initial level, and (3) as case (2) but with fricionless walls. (See also W90-05621) (Cassar-PTT)
W90-05661

APPLICATION OF MANNING FORMULA FOR POLISH SEWERS.
Institute of Environmental Protection, Warsaw (Poland).
P. Blaszczyk.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 362-371, 4 fig, 2 tab, 8 ref.

Descriptors: *Hydraulics, *Mannings equation, *Chezy equation, *Sewers, *Channel flow, *Pipe flow, Mathematical studies, Wastewater, Roughness coefficient, Hydraulic roughness, Flow velocity, Poland.

The Chezy formula, conventionally used in calculations of uniform sewage flow, and Manning's formula were compared in calculations of hydraulic properties in Polish closed sewers. Manning's formula proved satisfactory for such use, taking into account the variable roughness coefficient value, depending on the sewer wall roughness, Reynolds number, and flow phase. Failure to include these parameters in the calculations caused errors in velocity and flow rate for partially filled sewers. (See also W90-05621) (Cassar-PTT)
W90-05662

CHANNEL RESISTANCE AT THE SIDE-WEIR LOCATION IN OPEN CHANNEL FLOW.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
L. Yilmaz.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 372-382, 3 fig, 15 ref.

Descriptors: *Hydraulics, *Side weirs, *Channel flow, *Weirs, *Canals, *Flow, Mathematical studies, Flow control, Open-channel flow, Velocity distribution, Flow velocity, Mannings equation, Roughness coefficient, Hydraulic roughness, Resistance, Hydraulic resistance, Flood control, Irrigation canals, Drainage systems.

The performance of side weirs, typically used for water level control in irrigation and drainage canal systems, was investigated. The general differential equation of the water surface profile along the side weir in rectangular canals was derived from the energy equation. Assumptions were that the canal was infinitely long, the flow was uniform, and the specific energy was constant. Manning's formula was used to examine the energy variation and discharge variation. It was necessary to consider the interaction of the side weir size with other hydraulic factors. Diagrams were developed to show the relationships between the nondimensional weir discharge over unit length of side weir and the weir length, and the weir discharge coefficient and the weir length. Velocity vector angles with the canal axis along the side weir showed the same distribution as the nondimensional discharge. (See also W90-05621) (Cassar-PTT)
W90-05663

ESTIMATION OF MANNING'S ROUGHNESS COEFFICIENT IN ALLUVIAL STREAMS.
Queen's Univ., Belfast (Northern Ireland). Dept. of Agriculture for Northern Ireland.
N. N. J. Higginson, and H. T. Johnston.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 383-391, 7 fig, 8 ref.

Descriptors: *Hydraulics, *Streamflow, *Alluvial channels, *Mannings equation, *Channel morphology, *Roughness coefficient, Alluvial rivers, Flow velocity, River morphology, Flow depth, Mathematical studies, Particle size, Hydraulic radius, Bankfull stage, Open-channel flow.

A study relating flow resistance to channel geometry and bed material characteristics was undertaken on 68 rivers in Northern Ireland. Best fit equations for estimating Manning's n as power functions of the characteristic bed material size, slope and channel section were given. The value of Manning's n was highly correlated with the hydraulic radius for the channel sections used in this study. The relationship was nonlinear. The equation gave 65% of predictions of bankfull n values within a factor of 2 of the observed values. A method of predicting bankfull values of n was extended to estimation of flows down to half the channel capacity. The depth of flow at half the channel capacity was then used, together with the maximum in-bank depth and flow, to estimate a rating equation for the channel. (See also W90-05621) (Cassar-PTT)
W90-05664

NONLINEAR RESISTANCE RELATIONSHIPS FOR ALLUVIAL CHANNELS.
Interstate Commission on the Potomac River Basin, Rockville, MD.
R. Camacho, and B. C. Yen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 392-399, 3 fig, 1 tab, 9 ref.

Descriptors: *Hydraulics, *Streamflow, *Sediment transport, *Channel flow, *Alluvial channels, *Hydraulic friction, *Flow, Mathematical studies, Particle size, Sediments, Roughness coefficient, Mannings equation, Hydraulic roughness, Chezy equation, Weisbach equation, Particle size, Froude number.

A set of four nonlinear equations was proposed for the determination of the hydraulic resistance in alluvial channels with steady, reachwise, uniform flows with equilibrium sediment transport. An analytical study based on dimensional analysis and fluid mechanics concepts was conducted to determine the parameters involved in the functional relationship of these equations. These functional relationships were analyzed through stepwise multi-regression analysis of a sediment data bank of more than 7000 records. The Weisbach resistance coefficient was expressed as a nonlinear function of the Froude and Reynolds numbers and the relative sediment particle size. As the Froude number increased, the relative importance of the Reynolds number decreased. The relative sediment particle size gave some indication of sediment particle mobility. With increasing Froude number, the sediment particle mobility increased due to the increasing flow energy. For high Froude number flows (>1) the appearance of the Froude number reflected the effects of the wave resistance. (See also W90-05621) (Cassar-PTT)
W90-05665

ALLUVIAL STREAM HYDRAULIC RESISTANCE IN THE PRESENCE OF FILTRATION.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2E.
W90-05666

ANALYTICAL METHOD FOR COMPUTATION OF ROUGH BOUNDARY RESISTANCE.
Tri-State Univ., Angola, IN. Dept. of Civil Engineering.
S. Kumar.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 410-427, 8 fig, 1 tab, 21 ref.

Descriptors: *Hydraulic roughness, *Flow, *Flow resistance, *Hydraulics, *Channel flow, *Hydraulic friction, Resistance, Mathematical studies, Roughness coefficient, Turbulent flow, Shear stress, Stress, Pipe flow, Reynolds number, Flow velocity, Velocity distribution, Wake effects, Drag.

An analytical method for computing the resistance to flow on rough boundaries, based on the geometric characteristics of the roughness elements on the boundary, was developed. The flow resistance of a rough boundary was determined by estimating (1) the average height of the roughness elements, (2) the projected area of the elements on a plane normal to the flow for a given boundary area, and (3) the drag coefficient of the elements for a nonuniform velocity of approach. A chart was developed to facilitate computation of the flow resistance based on the aforementioned characteristics of the roughness elements on the boundary. The results of computations were compared with experimental results for different types of artificial and natural roughness. In the so-called completely turbulent zone, large viscous shear was sometimes present, contrary to literature on the subject. This was described as a Reynolds number independent regime. (See also W90-05621) (Cassar-PTT)
W90-05667

SAND-BED CHANNEL HYDRAULIC RESISTANCE ESTIMATION.
People's Friendship Univ., Moscow (USSR).
E. K. Rabkova, and V. K. Rumjantsev.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 428-433, 3 ref.

Descriptors: *Alluvial channels, *Mannings equation, *Chezy equation, *Hydraulics, *Channel flow, *Hydraulic friction, *Flow, Sand, Roughness coefficient, Hydraulic roughness, Mannings equation.

Chezy's coefficient and Manning's coefficient n were calculated for sand-bed channels with sand particles of 0.1 to 0.25 mm diameter and channel width/depth relationships of 10 to 50. Field data from channels fitting these requirements were the Carakum, North Crimea and Kizketken channels in the Soviet Union, and Sarda and Hardoy channels in Pakistan. 'Surface of the channel' patterns were used when calculating the field Chezy's coefficient, the measured values of the mean velocities, the mean depths, and the slopes of the water. In calculating the field roughness coefficient it was decided to adopt a constant value for the exponent (y) in Chezy's formula. By plotting the corresponding values of the roughness coefficient, a linear equation was derived that was used to demonstrate the influence of bed relief on the roughness coefficient. (See also W90-05621) (Cassar-PTT)
W90-05668

SOME SUGGESTIONS FOR FRICTION AND MEAN VELOCITY OF FLOW IN PIPES.

Nihon Univ., Koriyama. Coll. of Engineering.
Y. Fujita, and T. Yasuda.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 434-443, 9 fig, 1 tab, 3 ref.

Descriptors: *Hydraulics, *Pipe flow, *Flow friction, *Hydraulic friction, *Flow, Flow velocity, Velocity, Friction, Hydraulic roughness, Roughness coefficient, Mannings equation, Hydraulic resistance, Resistance, Chezy equation, Hazen-Williams equation, Mathematical studies.

Friction and mean velocity of flow in polyvinyl chloride pipes were calculated using several widely used hydraulic equations (Prandtl-Karman's, Colebrook-White's, Chezy's, Manning's, Hazen-Williams', and Weston's) and several equations modified by the authors. The new equations were easier to use, more theoretical, and had constant coefficients, in contrast to the previously-used equations. (See also W90-05621) (Cassar-PTT)
W90-05669

CONSIDERATION OF WALL SHEAR STRESS AND FRICTION FACTORS.
Nihon Univ., Koriyama. Coll. of Engineering.
T. Yasuda.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 444-452, 5 fig, 3 tab, 2 ref.

Descriptors: *Flow friction, *Hydraulics, *Shear stress, *Pipe flow, *Flow, *Hydraulic friction, Mathematical studies, Laminar flow, Flow velocity, Darcy-Weisbach equation, Mannings equation, Chezy equation, Hydraulic roughness, Roughness coefficient.

New equations were developed to better describe wall shear stress and friction factors in pipes. Formerly, stress was regarded as directly proportional to kinetic energy of fluid per unit volume, and its coefficient was defined as the friction factor. This relationship was found to be valid only in the wholly rough turbulent flow region with a large Reynolds number, but not in other flow regions. The Darcy-Weisbach formula for loss of head and the Chezy formula for mean velocity were found valid within the former region, but the Manning formula was found invalid within any region. (See also W90-05621) (Cassar-PTT)
W90-05670

DIMENSIONLESS MANNING-TYPE EQUATION.
Cincinnati Univ., OH.
L. M. Laushey.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 453-461, 1 fig 3 tab, 9 ref.

Descriptors: *Hydraulics, *Streamflow, *Flow, *Channel flow, *Hydraulic roughness, *Channel morphology, *Mannings equation, Roughness coefficient, Mathematical studies, Chezy equation, Hydraulic radius, Streambeds, Ripples, Dunes, Pools, Turbulent flow, Unsteady flow, Open-channel flow.

A dimensionless equation was proposed for the velocity in streams with fully-developed turbulence where the boundary roughness can be determined. The exponent on the hydraulic radius in the Chezy-Manning equations was calculated as 0.62. This equation was comparable to the Manning equation but not necessarily identical. It proved useful in streams with very rough or non-planar movable material, such as boulders, ripples, dunes, or chutes and pools. (See also W90-05621) (Cassar-PTT)
W90-05671

GENERALIZED FORMULA FOR THE CHEZY COEFFICIENT FOR THE RIVER FLOW.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
G. V. Zheleznyakov.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 462-467, 6 ref.

Descriptors: *Hydraulics, *River flow, *Flow, *Channel flow, *Chezy equation, Mathematical studies, Open-channel flow, Hydraulic friction, Hydraulic radius, Mannings equation, Roughness coefficient, Hydraulic roughness.

A general formula for the Chezy coefficient was derived based on the logarithmic formula for the hydraulic friction coefficient into which is introduced a variable value of the parameter of the logarithmic velocity diagram. It was shown to be valid within a wide range of hydraulic radii and channel roughness coefficients. It was also demonstrated that the Manning formula is a particular case of the suggested generalized formula for the Chezy coefficient. (See also W90-05261) (Cassar-PTT)
W90-05672

EXAMINATION OF STAGE-DISCHARGE RELATIONSHIPS OF COMPOUND/COMPOSITE CHANNELS.
WEST Consultants, Inc., San Diego, CA.
D. R. Williams, and P. Y. Julien.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 478-488, 7 fig, 37 ref.

Descriptors: *Channel morphology, *Streamflow, *Stage-discharge relations, *Compound channels, *Model studies, *Hydraulics, *Flow, *Channel flow, Open-channel flow, Mathematical studies, River flow, Roughness coefficient, Hydraulic roughness, Shear stress, Flood flow, Hydraulic friction, Literature review.

The nature of compound channels and problems associated with their calculations are reviewed. Compound channels have lateral subsections with significantly different hydraulic characteristics. For model studies, a compound channel can be composited into equivalent roughness parameters. Compositing can be done by the single channel method, the separate channel method, and a method which considers the interaction between the channels and overbanks. Problems associated with modeling of compound channels are involved with flood routing, critical flow, distribution of shear stress and horizontal velocity, meandering, sediment transport, and inappropriate model calibration and extrapolation. Several methods are available for compound channel analysis: weighted roughness methods, the imaginary wetted perimeter method, the apparent shear stress method (found not applicable to field conditions), the friction correction factor, and two-dimensional and three-dimensional approaches. Most of the studies on compound channel flow involve flume experiments, and little field data is available. Under these conditions the weighted roughness and imaginary wall methods, in conjunction with engineering judgement, must be used. (See also W90-05621) (Cassar-PTT)
W90-05674

MODEL-PROTOTYPE COMPARISONS OF BOUNDARY RESISTANCE IN A TWO STAGE CHANNEL.
Queen's Univ., Belfast (Northern Ireland).
H. T. Johnston, Y. L. Lau, and N. N. J. Higginson.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 489-498, 10 fig, 1 tab, 10 ref.

Descriptors: *Hydraulics, *Channel flow, *Berm, *Compound channels, *Model studies, Flow velocity, Roughness coefficient, Hydraulic roughness, Berms, Boundary processes, Flood plains, Shear stress, Water depth, Mannings equation, Mathematical studies, Flumes, Flow.

Flow in a two-stage trapezoidal channel, as studied in a 11.5-m long physical model and a numerical model, was found to be highly dependent on the roughness of the berm. The percentage of the total flow carried by the berms even in smooth channels was small relative to two-stage channels of rectangular cross section. The Manning roughness coefficient averaged over the cross section decreased with increasing depth until the berms were covered and then increased until the depth on the berms was large relative to the depth of the primary channel. The magnitude of this relative depth was greater when the berms were rough. The roughness on the berms was best represented as distributed over the depth of flow. (See also W90-05621) (Cassar-PTT)
W90-05675

MOMENTUM TRANSFER IN COMPOUND CHANNELS.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
D. Stephenson, and P. Kolovopoulos.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 499-508, 6 fig, 12 ref.

Descriptors: *Hydraulics, *Channel flow, *Flood flow, *Compound channels, *Flood plains, *Model studies, Flow, Hydrographs, Mathematical studies, Flood routing, Shear stress, Momentum transfer, Prinos equation.

The mechanism of momentum transfer between a main channel and its flood plains was analyzed under steady and unsteady-state conditions. From the evaluation of various steady-state methods, it was concluded that the area method was most promising for computing discharge and that the Prinos model gave the most accurate results for the apparent shear force at the interface of the main channel and flood plain. Incorporation of these features in the model allowed analysis of the effect of momentum transfer in flood routing. A range of hydrographs was routed through a compound channel with symmetrical flood plains. The momentum exchange resulted in: (1) an attenuation of the flowrate hydrographs at low depths, (2) a delay in the falling of the water levels, (3) a shaft on the loop-rating curve, and (4) an increase in the flood plain flow and a decrease of the main channel carrying capacity. (See also W90-05621) (Cassar-PTT)
W90-05676

COMPOUND CHANNEL FROUDE NUMBER FOR MANNING'S N VARIABLE WITH DEPTH.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
T. W. Sturm.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 509-517, 6 fig, 19 ref.

Descriptors: *Flood flow, *Streamflow, *Hydraulics, *Channel flow, *Mannings equation, *Compound channels, Water depth, Froude number, Roughness coefficient, Hydraulic roughness, Overflow, Flow, Open-channel flow.

The compound channel Froude number for Manning's n variable with depth was used to investigate critical depth in overbank flow in compound channels. Manning's n variation with depth increased the influence of the rate of change in the kinetic energy flux correction coefficient with respect to depth on the value of the Froude number. The compound channel Froude number with constant Manning's n was recommended for use only

in situations for which Manning's n was not sensitive to depth. (See also W90-05621) (Cassar-PTT)
W90-05677

MANNING'S N OF COMPOSITE ROUGHNESS IN CHANNELS OF SIMPLE CROSS-SECTION.
City Univ., London (England). Dept. of Civil Engineering.
T. P. Flintham, and P. A. Carling.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 518-529, 4 fig, 1 tab, 19 ref.

Descriptors: *Streamflow, *Hydraulic roughness, *Flow, *Hydraulics, *Channel flow, *Mannings equation, Roughness coefficient, Mathematical studies, Pavloski equation, Colebatch equation, Einstein equation, Lotter equation.

The effective Manning's n was estimated using a composite roughness formula in differentially roughened channels. The predictive accuracy of four composite roughness formulas was studied; equations were by Einstein, Pavloski, Colebatch, and Lotter. The Pavloski equation was most appropriate for the application. It predicted the effective coefficient to an accuracy of about 8% with 95% confidence limits with certain provisions. Subarea division according to velocity contour pattern did not significantly improve the predictive accuracy. When appropriate constant component Manning's n values were used, the Pavloski equation predicted the effective n value to within 15% with 95% confidence limits. (See also W90-05621) (Cassar-PTT)
W90-05678

EFFECTS OF ASPECT RATIO AND SIDEWALL ROUGHNESS ON VELOCITY DISTRIBUTION AND RESISTANCE COEFFICIENT IN RECTANGULAR OPEN CHANNELS.
Tsinghua Univ., Beijing (China). Dept. of Hydraulic Engineering.
Y. Hui, and N. Chunhong.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 530-538, 10 fig, 10 ref.

Descriptors: *Hydraulic roughness, *Hydraulics, *Streamflow, *Channel flow, *Flow, Velocity distribution, Flow velocity, Open-channel flow, Roughness coefficient, Resistance, Flumes, Aspect ratio, Mathematical studies, Shear stress, Cross-section.

A series of experiments were conducted in a rectangular flume by varying aspect ratio and sidewall roughness. The vertical velocity distributions along cross sections were analyzed. It was shown that every velocity profile could be divided into a logarithmic velocity region in the lower part and a parabolic velocity region in the upper part, according to the characteristics of every vertical velocity distribution. Although aspect ratio and sidewall roughness had no effect on the form of vertical velocity distribution formula for each region, they affected the ratio of the height to the water depth (beta) and the ratio of the height of maximum velocity point to the water depth (alpha). Both alpha and beta coefficients decreased gradually from the centerline to the sidewall and increased with sidewall roughness. In this experiment alpha values were 0.45 to 1.0 and beta, 0.05 to 0.25. Resistance coefficients of smooth and rough open channel flow were analyzed by varying aspect ratio and sidewall roughness. Separation of bed resistance coefficient and sidewall resistance coefficient was analyzed under different conditions of bed and sidewall roughness. (See also W90-05621) (Cassar-PTT)
W90-05679

REPLACING THE HYDRAULIC RADIUS IN MANNINGS FORMULA.
Florida Univ., Gainesville. Dept. of Civil Engineering.
B. A. Christensen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 549-558, 2 fig, 5 ref.

Descriptors: *Hydraulics, *Channel flow, *Mannings equation, *Roughness coefficient, *Hydraulic radius, Shear stress, Open channels, Water depth, Cross-sections.

A replacement for the hydraulic radius as the cross-sectional dimension in Manning's formula was sought for use in open channels. Two approximations of the true boundary shear stress distribution were explored, and formulas for a more realistic conveyance depth were developed. A symmetrical trapezoidal cross section was used in all three formulas. Maximum depths (in meters) obtained were as follows: hydraulic radius method, 2.668; local vertical depth method, 2.429; and local normal depth method, 2.473. Cross-sectional areas (in sq m) corresponding to these depths were as follows: 24.9, 21.5, and 22.1, respectively. (See also W90-05621) (Cassar-PTT)
W90-05681

PHYSICALLY BASED MODEL FOR DETERMINING FLOW RESISTANCE AND VELOCITY PROFILES IN VEGETATED CHANNELS.
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
C. Saowapon, and N. Kouwen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 559-568, 6 fig, 31 ref.

Descriptors: *Hydraulics, *Channel flow, *Vegetation, *Flow resistance, *Streamflow, *Model studies, *Hydraulic roughness, *Flow velocity, Model studies, Mathematical studies, Velocity distribution, Roughness coefficient, Open-channel flow, Turbulent flow, Flumes, Mannings equation.

A physically based model was developed for studying resistance parameters and velocity profiles for open channel lines with artificial flexible roughness. The model consisted of a flume with embedded plastic strips of various stiffness to simulate vegetation. The parameters of the model were as follows: the plastic strip length and stiffness, coefficient of drag, and eddy viscosity. Laboratory results showed that the model accurately predicted velocity profile measurements for erect and waving roughness. The model analytically predicted the friction factor or other roughness coefficient. The results for artificial grass lying flat were not satisfactory because the Manning's n value was overpredicted. (See also W90-05621) (Cassar-PTT)
W90-05682

HYDRAULIC MODEL OF OVERLAND FLOW ON GRASS COVERED SLOPES.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
D. D. Adrian, and C. J. Martel.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 569-578, 4 fig, 14 ref.

Descriptors: *Land disposal, *Hydraulics, *Wastewater treatment, *Model studies, *Overland flow, Shallow flow, Mathematical studies, Wastewater disposal, Grasses, Vegetation, Mannings equation, Uniform flow, Slopes, Drag, Hydraulic roughness, Roughness coefficient.

A one-dimensional model of the hydraulic behavior of wastewater flowing down a grass-covered slope of an overland flow system was developed. The model was based on the assumption of laminar and uniform flow. It accounted for the resistance imparted by grass as well as the resistance imparted by the soil. Velocity was treated as varying with depth. The model did not account for the tortuous flow paths of the fluid around each blade of grass but assigned a drag coefficient dependent on the Reynolds number, which in turn, was based on the grass diameter. The parameter representing the effect of the grass in changing the flow increased as average flow velocity decreased. When this parameter was <1, the grass had a negligible effect on the average velocity; when it was 100, the average velocity was about 10% of the unimpeded velocity. (See also W90-05621) (Cassar-PTT)
W90-05683

DETERMINATION OF MANNING'S N AND FRICTION FACTOR IN VEGETATED WATERWAYS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
G. N. Paudyal, and B. Panigrahi.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 579-588, 5 fig, 2 tab, 4 ref.

Descriptors: *Hydraulics, *Channel flow, *Vegetation, *Mannings equation, *Hydraulic roughness, Waterways, Roughness coefficient, Friction, Hydraulic friction, Flow resistance, Hydraulic resistance, Weisbach equation, Shallow channels, Grasses, Reynolds number, Mathematical studies, Drainage systems, Irrigation canals, Canals, Overland flow.

Resistance coefficients were experimentally determined in shallow channels lined with three types of grass commonly found in Thailand. The boundary resistances of vegetated waterways were higher than those of unlined channels, and they depended on the heights and densities of the grasses. The most obvious differences were found in grass-lined channels in the very high range of Weisbach friction factor and Manning's n value. Both the friction factor and the roughness coefficient decreased with the increase in flow velocity. The friction factor decreased with the increase in the flow Reynolds number. (See also W90-05621) (Cassar-PTT)
W90-05684

FACTORS AFFECTING ROUGHNESS COEFFICIENT IN VEGETATED CHANNELS.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
C. Nalluri, and N. D. Judy.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 589-598, 9 fig, 1 tab, 6 ref.

Descriptors: *Hydraulics, *Hydraulic roughness, *Mannings equation, *Channel flow, *Streamflow, *Vegetation, Roughness coefficient, Hydraulic resistance, Flow resistance, Flumes, Chezy equation, Drag, Flow velocity, Velocity distribution.

Laboratory experiments were carried out to determine the resistance in vegetated channels under different flow conditions. Two types of roughness elements were used: 5-mm wide strips from a 0.5-mm plastic sheet cut to lengths of 40, 80, nd 160 mm and plastic tubes of 6-mm diameter and 150 mm length. These were placed in staggered and parallel arrangements with a variety of distributions and densities. The most important factor affecting the resistance in the experimental channels, as expressed by Manning's n value and the Chezy coefficient, was the relative submergence depth of the roughness elements. Shape, concentration, and distribution of the simulated vegetation was only significant at shallow depths. (See also W90-05621) (Cassar-PTT)
W90-05685

HYDRAULICS RESEARCH IN MOUNTAIN RIVERS.
Geological Survey, Denver, CO.
R. D. Jarrett.
IN: Proceedings of the International Conference

on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 599-608, 6 fig, 1 tab, 16 ref.

Descriptors: *Stream gages, *Hydraulic roughness, *Streamflow, *Hydraulics, *Rivers, *Flow measurement, *Mountains, Flow resistance, Hydraulic resistance, Mannings equation, Roughness coefficient, Flow velocity, Turbulent flow, Wild rivers, Measuring instruments, Price current meter.

Results to date of an ongoing research project on hydraulics in mountain rivers in Colorado and in flumes are reported. Gradients of these rivers are greater than 0.002 m/m. Preliminary data show that: (1) flow resistance varies inversely (and substantially) with depth of flow and varies directly with river gradient (or friction slope), (2) velocity head coefficients vary inversely with relative smoothness and directly with river gradient, (3) flow predominantly is subcritical, (4) vertical-velocity profiles are S-shaped and not logarithmic (the velocities are slower near the streambed than for a logarithmically distributed profile and are faster near the water surface), and (5) the Price AA current meter may consistently over-register velocity in turbulent mountain-river flow. (See also W90-05621) (Cassar-PTT)
W90-05686

STUDY ON THE MANNING'S ROUGHNESS COEFFICIENT OF STEEP MOUNTAINOUS STREAMS IN TAIWAN.
National Chunghsing Univ., Taichung (Taiwan). Graduate Inst. of Soil and Water Conservation.
C. W. Ho, and H. P. Huang.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 609-617, 3 fig, 5 ref.

Descriptors: *Hydraulics, *Streams, *Mountain streams, *Hydraulic roughness, *Mannings equation, *Taiwan, *Flow characteristics, *Sediment transport, Roughness coefficient, Streambeds, Cho-Shui Stream, Mathematical studies, Flumes, Model studies.

Formulas were developed to describe the hydraulic conditions in mountainous streams which are very steep and have coarse-grained sediment. These formulas expressed the relationship between the dimensionless Manning's roughness factor and other parameters. Flume experiments, using gravels of 2.2 to 15.0 mm diameter, were used to develop the formulas. Field data collected in the upstream part of Cho-Shui Stream, Taiwan, verified the formula with satisfactory results. (See also W90-05621) (Cassar-PTT)
W90-05687

FROUDE NUMBER IN THE EVALUATION OF THE FRICTION FACTOR IN THE NATURAL RIVERS.
Universita di Reggio Calabria, Cosenza (Italy). Dipt. di Difesa del Suolo.
C. Colosimo, M. Veltri, and B. Mendicino.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 618-627, 2 fig, 2 tab, 16 ref.

Descriptors: *Hydraulics, *Rivers, *Froude number, *Hydraulic friction, *Streamflow, Keulegan equation, Mathematical studies, Flow velocity, Velocity distribution, River beds, Sediment transport, Bed load, Italy.

Data from 43 river reaches in Italy were used to define the optimum value of a (constant) in the Keulegan equation, which estimates the average flow velocity. In addition, best fit relationships for estimating friction factor as power functions and as logarithmic functions were adopted. A simplified method for the assessment of friction factor was also developed, starting with the Keulegan equation and accounting for parameters which describe the presence or the lack of bed load transport and the influence of the Froude number. (See also W90-05621) (Cassar-PTT)
W90-05688

MANNING'S N IN GRAVEL BED RIVERS.
Pahlavi Univ., Shiraz (Iran). Dept. of Irrigation.
M. Javan, E. McKeogh, and M. Yasi.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 628-637, 1 fig, 7 tab, 20 ref.

Descriptors: *Alluvial channels, *Channel morphology, *Hydraulics, *Mannings equation, *Hydraulic roughness, *River flow, *Flow characteristics, Roughness coefficient, Fahlian River, Iran, Floods, Gravel, Flow characteristics, Mathematical studies, River beds.

Values for Manning's n were calculated using flow data collected before and after a flood in the Fahlian River, Iran. The roughness coefficients obtained during normal flows were less than the values obtained during high flows. After the flood, the n values were less. The size of the bed material used as the main parameter in empirical formulas was dependent on the flow regime of the gravel bed rivers. During low flow, sand dunes were observed, while during floods and high flows, grain size distribution of the bed material changed drastically. This change affected the water surface profile and, in turn, the n values. Therefore, it was recommended that the n value be measured in a river before using it in an empirical formula. Based on the size distribution of the bed material, empirical formulas were developed for low and high flow regimes. (See also W90-05621) (Cassar-PTT)
W90-05689

RIFFLE-POOL FORMATIONS IN NORTHERN IRELAND RIVERS.
Department of Agriculture for Northern Ireland, Belfast.
N. N. J. Higginson, and H. T. Johnston.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 638-647, 7 fig, 4 tab, 9 ref.

Descriptors: *Channel morphology, *Channel improvement, *River beds, *Hydraulics, *Rivers, *Riffles, *Channel flow, Pools, Main River, Northern Ireland, Fish management, Aquatic habitats, Mannings equation, Roughness coefficient, Hydraulic roughness, Sediment transport, Alluvial rivers.

Alluvial rivers and streams in North Ireland were studied in order to develop a method of predicting the natural location and spacing of riffles so that they can be regenerated after stream improvement activities. The bed widths of the study streams were 2 to 50 m; the slopes were 1:70 in mountain streams to 1:1000 in the lower reaches. River improvement schemes had been carried out on most of the channels during the past 30 years. Rivers showing no riffle formation had bed materials (D50) less than 3 mm. Where riffles were found, the D50 size for the riffles were 20 to 200 mm. The median particle size in a riffle was greater than that in the pool by a factor of 2. Coarser material was found in the riffle than in the pool. Marked stones placed in a riffle were found in downstream riffles after a flood. The value of the Manning n coefficient applicable at low flows varied greatly along a pool-riffle sequence. At high flows, the effect of the bed formation had little effect, and uniform flow could be assumed. Riffle spacing was found to be non-linearly related to the channel slope. The formula developed to describe this was dependent on channel width and slope and the median particle sizes in the bed material at pool and riffle locations. Sets of riffles with long pools between were observed in natural rivers. The group length was related to the channel width and the medial particle size forming the riffles. The average spacing within the groups was related to channel width and slope and the bed material sizes. (See also W90-05621) (Cassar-PTT)
W90-05690

COMPARISON OF VELOCITY MEASUREMENTS IN STRAIGHT, SINGLE MEANDER AND MULTIPLE MEANDER COMPOUND CHANNELS.
University Coll., Cork (Ireland). Dept. of Civil Engineering.
E. J. McKeogh, and G. K. Kiely.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 648-658, 20 fig, 1 tab, 12 ref.

Descriptors: *Hydraulics, *Streamflow, *Channel flow, *Flow characteristics, *Meanders, *Flow velocity, Compound channels, Velocity distribution, Flood flow, Channel morphology, Flood plains, Mathematical studies.

Velocity measurements were taken for three different types of flood flow situations in compound channels (straight, single meander, multiple meander) to examine and compare the interaction mechanisms between flood plain and main channel flows. Measurements were done with the Laser Doppler Anemometer oriented to measure the resultant velocity component. The depth-averaged lateral velocity distributions for the straight channel fit exponential and power functions; however, the velocity distributions for the meandering channels, which vary from cross section to cross section, were more difficult to fit into a general equation. Flow velocities in flood plains in meandering channels were greater than in straight channels. At bends, the maximum velocity was shifted toward the inner bank. In the straight channel the lateral velocity distribution for different depth ratios showed steeper velocity gradient across the interface at lower depth ratios. (See also W90-05621) (Cassar-PTT)
W90-05691

COMPARISON OF TURBULENCE MEASUREMENTS IN STRAIGHT, SINGLE MEANDER AND MULTIPLE MEANDER COMPOUND CHANNELS.
University Coll., Cork (Ireland). Dept. of Civil Engineering.
G. Kiely, M. Javan, and E. J. McKeogh.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 659-668, 15 fig, 15 ref.

Descriptors: *Hydraulics, *Streamflow, *Channel morphology, *Flood flow, *Channel flow, *Turbulent flow, *Flow velocity, *Flow characteristics, *Meanders, Mathematical studies, Compound channels, Velocity distribution, Flood plains.

Velocity and turbulence measurements were taken for three different types of flood flow situations in compound channels (straight, single meander, multiple meander) to examine and compare the turbulent flow mechanisms between flood plain and main channel flows. Measurements were taken using a Laser Doppler Anemometer oriented to measure the resultant velocity and turbulence component. The lateral turbulence intensity profiles in the straight compound channel showed a variation of 6 to 12% with lowest values near the water surface and highest values near the bed. The meandering geometries showed similar trends with higher magnitudes. The contours of turbulence intensity for the straight channel showed a transfer of turbulence from the flood plain to the main channel. This was also true for the meandering geometries. Increased turbulence intensity values were seen at the inner bend for both meander geometries. The highest turbulence index (up to 25%) in the meander geometries were observed on the flood plains adjacent to the downstream interface of the crossover sections between bends. The turbulence intensity decreased from the bend entrance toward the exit due to accelerated flow. Measurements of the longitudinal turbulence (depth-averaged) were useful in determining the

eddy viscosity, and thus the answer to the simplified dynamic equation, in straight compound channels. (See also W90-05621) (Cassar-PTT)
W90-05692

FLOW BEHAVIORS IN HEADRACE TUNNEL OF RUN-OF-THE-RIVER POWER STATIONS.
Kyoto Univ. (Japan). Dept. of Civil Engineering.
Y. Iwasa, and S. Yokosi.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 669-678, 14 fig, 3 tab, 5 ref.

Descriptors: *Pipe flow, *Hydraulics, *Hydraulic structures, *Powerplants, *Flow characteristics, *Tunnels, *Electric powerplants, *Hydroelectric plants, Headrace tunnel, Mathematical studies, Unsteady flow, Mannings equation, St Venant equation, Roughness coefficient, Rivers, Channel flow, Hydraulic roughness.

Flow behavior in run-of-the-river hydropower stations was studied using the St. Venant equation with the Manning formula. Two situations were examined: (1) the entrance of water into a vacant headrace tunnel under a sudden increase in load; and (2) load interception at the head tank. Numerical analysis results were satisfactory, indicating that the equations could be used for practical design purposes. (See also W90-05621) (Cassar-PTT)
W90-05693

EFFECTS OF DIFFERENTLY SHAPED OBSTACLES ON A RAPID STREAM EXPANSION.
Basilicata Univ., Potenza (Italy). Inst. of Hydraulics and Hydraulic Construction.
B. Molino.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 679-687, 7 fig, 10 ref.

Descriptors: *Streamflow, *Flow around objects, *Model studies, *Hydraulics, *Channel flow, Rapid flow, Flow characteristics, Unsteady flow, Mathematical studies, Froude number.

A physical model was constructed to study the effects on flow patterns of obstacles placed on the bottom of a divergent channel in which a rapid stream flowed. The three types of obstacles were a semi-ellipsoidal shaped bottom, traverses at regular distances along the axis of the channel, and rows of teeth. The arrangement of traverses allowed the most rapid stream expansion. The semi-ellipsoid shape allowed expansion of the stream; however, this effect was negated when aperture angles of the walls of the divergent channel were greater than 16 degrees. The tooth arrangement was least efficient in allowing rapid stream expansion. (See also W90-05621) (Cassar-PTT)
W90-05694

FRICTIONAL RESISTANCE TREATMENT IN UNSTEADY OPEN-CHANNEL FLOW SIMULATION.
Geological Survey, Reston, VA. Water Resources Div.
C. Lai, R. W. Schaffranek, and R. A. Baltzer.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 688-698, 2 fig, 3 tab, 9 ref.

Descriptors: *Hydraulics, *Channel flow, *Model studies, Flow, Resistance, Hydraulic friction, Mathematical studies, Open-channel flow, Unsteady flow, Numerical analysis.

The treatment of the frictional resistance term in unsteady open-channel flow simulation models was investigated using various combinations of dependent variables and boundary conditions. A nondimensional form of the characteristics equations derived from the governing equations was used as the basis for a systematic set of numerical experiments and analyses. Findings indicated that both the particular boundary conditions used and other nonhomogeneous terms considered in the equation set had significant effects on evaluation of the flow-resistance coefficient. The model was applied to data from Threemile Slough in California, and practical suggestions made for proper and optimal treatment of the frictional resistance coefficient. (See also W90-05621) (Cassar-PTT)
W90-05695

FLOOD ROUTING MODELS AND THE MANNING N.
National Weather Service, Silver Spring, MD. Hydrologic Research Lab.
D. L. Fread.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 699-708, 10 fig, 1 tab, 16 ref.

Descriptors: *Flood forecasting, *Flood flow, *Hydraulics, *Rivers, *Flood routing, *Channel flow, *Mannings equation, Hydraulic roughness, Roughness coefficient, Routing, Model studies, Mathematical studies, Flow resistance, Unsteady flow, DWOPER model, Mississippi River, Alluvial rivers, Vegetation, Dam failure, Floods, River beds.

The selection of n values for use in flood routing models was studied with respect to: (1) the use of historical flood observations, and (2) the situation with no available observed flood data. The DWOPER flood routing model was used to obtain Manning's n values for rivers with unsteady flows. For the Baton Rouge-Donaldsonville reach of the Mississippi River and the Shawneetown-Fords Ferry reach of the Ohio River, the n value increased with increasing discharge. This was attributed to the resistance produced by bank vegetation as the water rose to that level. Manning's n values decreased with increasing discharge in another type of river, those where the increase in the overbank flow area is relatively small compared to the increase of flow area within bank (Donaldsonville-New Orleans reach, Cairo-Caruthersville reach, and Chester-Cairo reach of the Mississippi and the Kentucky Dam-Ohio River reach of the Tennessee River. Numerical and analytical studies were described which illustrate the effect of the uncertainty associated with selected n values on the routing model's predicted stages. Changes in n value for a single reach were shown to affect computed stages at all points along the river. Simulation of 13 historical floods (1959-1971) on the lower Mississippi with the calibrated Manning n revealed an average root-mean-square error of 0.47 ft. A methodology was presented for including within flood routing models the combined frictional effects of dynamic alluvial bed forms and overbank vegetation. (See also W90-05621) (Cassar-PTT)
W90-05696

ESTIMATION OF THE MANNING-STRICKLER ROUGHNESS COEFFICIENT IN SAINT-VENANT EQUATIONS.
Laboratoire National d'Hydraulique, Chatou (France).
A. Lebosse.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 709-718, 2 fig, 7 ref.

Descriptors: *Hydraulics, *Mannings equation, *Channel flow, *Streamflow, *Roughness coefficient, Hydraulic roughness, Mathematical studies, St Venant equation, Manning-Strickler coefficient, Open-channel flow, Unsteady flow, Garonne River, Flood flow, France.

An iterative method is presented for estimating the values of the Manning-Strickler roughness coefficient in the one dimensional Saint-Venant equations, using the Manning friction law for open channels. Data requirements are a set of flow level measures obtained during a flood. The river is divided into several segments. One (main channel) or two (main channel and flood plain) coefficients are estimated for each segment. The iterative procedure has two steps. First, the gradient of this function is computed, using control techniques in the discrete, linearized Saint-Venant equations. Second, a new value is obtained for each segment by means of a gradient descent method. The procedure, tested on a prismatic channel and a natural stream (Garonne River, France), was proved to converge in any case provided that at least one measure for each segment was available. Determination of both main channel and flood plain coefficients requires performing two separate estimations, using two relevant sets of measures. The method has the advantage of smoothing coefficients. (See also W90-05621) (Cassar-PTT)
W90-05697

OPTIMUM MANNING ROUGHNESS COEFFICIENTS FOR USE IN A FINITE ELEMENT OVERLAND FLOW MODEL.
Virginia Dept. of Conservation and Historic Resources, Richmond.
I. S. Sandhu, and D. N. Contractor.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 719-730, 6 fig, 1 tab, 5 ref.

Descriptors: *Hydraulics, *Rainfall-runoff relationships, *Overland flow, *Runoff, *Mannings equation, *Roughness coefficient, Hydraulic roughness, Flow, Model studies, Mathematical models, Forests, Watersheds, Storms, Flood routing, Turbulent flow, Land use.

Values for Manning's roughness coefficients for overland flow were investigated in a finite element routing model applied to the Upper South River watershed in Virginia. The magnitude of roughness coefficients for overland flow was generally much higher than roughness coefficients for open channel flow. For turbulent overland flow, the roughness coefficient was a function of land use and the Reynolds number of the flow. Four storms and four land uses (woods, two agricultural areas, and a residential area) were considered. (See also W90-05621) (Cassar-PTT)
W90-05698

TWO-DIMENSIONAL HIGH SPEED OPEN CHANNEL FLOW FRICTION EFFECTS.
Demokritos Univ. of Thrace, Xanthi (Greece). Dept. of Civil Engineering.
J. V. Soulis.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 731-740, 8 fig, 11 ref.

Descriptors: *Hydraulics, *Channel flow, *Hydraulic friction, *Open-channel flow, *Flow, Model studies, Friction, Mathematical studies, Rapid flow, Slopes, Flow velocity, Velocity distribution.

A numerical method was developed for calculation of the two-dimensional, high speed, open-channel flow, including the usually neglected terms of slope and friction. Flow was assumed to be fully mixed in the vertical direction so that vertical variations could be neglected. The method was applied to a variety of open channel configurations, including a gradually expanding configuration. Charts indicated the differences between frictionless, zero slope conditions and realistic conditions. The proposed numerical scheme agreed satisfactorily with observed results. (See also W90-05621) (Cassar-PTT)
W90-05699

TRANSIENT CHANNEL FLOW ROUTING USING FIXED-POINT ITERATION METHOD.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.

A.-S. M. Shakir, and A.-I. Y. Mohammed.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 741-748, 4 fig, 8 ref.

Descriptors: *Hydraulics, *Streamflow, *Unsteady flow, *Channel flow, Model studies, Mathematical models, Newton-Raphson method, Tigris River, Iraq, Flow, St Venant equation, Hydrographs, Mannings equation, Hydraulic roughness, Roughness coefficient.

An efficient iteration method was devised to solve the implicit formulation of the one-dimensional St. Venant equations. Rather than apply the Newton-Raphson technique, as is customary in these methods, the computation of discharge corrections was uncoupled from computation of depth corrections. The Newton-Raphson technique was applied only to the momentum equations to compute discharge corrections. Improved values of depth were computed from a fixed-point iteration function derived from Manning's formula. This halved the number of equations in the iteration system as compared with ordinary methods. The new technique was applied to a 60-km reach of the Tigris River within the city of Baghdad, Iraq. Model results agreed satisfactorily with field observations, and the computation time was 25% of the time required by ordinary methods. (See also W90-05621) (Cassar-PTT)
W90-05700

STUDY ON THE LINEARIZED ANALYTICAL AND NUMERICAL SOLUTION FOR UNSTEADY OPEN CHANNEL FLOW.
Tamkang Univ., Taipei (Taiwan). Dept. of Water Resources and Environmental Engineering.
S.-H. Wang.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 759-766, 10 fig, 1 tab, 4 ref.

Descriptors: *Hydraulics, *Channel flow, *Open-channel flow, *Flow characteristics, *Unsteady flow, Model studies, Mathematical studies, Numerical analysis, Backwater effect, Hydrographs.

A linearized analytical solution was proposed for simulating unsteady open channel flow in various cross-sectional shapes (triangular, rectangular, and trapezoidal) where significant backwater effects exist. An error analysis of reference discharge was made to obtain the best solution. The proposed method was compared with a nonlinear dynamic wave model, which is solved by an explicit finite difference method. The linearized analytical solution was a good approximation, provided a reference discharge was chosen between the mean flow and one-third of peak flow. (See also W90-05621) (Cassar-PTT)
W90-05702

UNCERTAINTY ON TRAVEL TIME IN KINEMATIC WAVE CHANNEL ROUTING.
Wyoming Water Research Center, Laramie.
Y.-K. Tung.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 767-781, 1 fig, 6 tab, 18 ref.

Descriptors: *Unsteady flow, *Hydraulics, *Streamflow, *Kinematic wave theory, *Channel flow, *Flood forecasting, *Flood routing, Model studies, Mathematical studies, Flood waves, Kinematic wave model, Wave velocity, Mellin transform, Flow velocity, Disasters, Warning systems, Flood peak.

A probabilistic analysis using the Mellin transform was performed to assess the uncertainty in computing the travel time of flood waves in a channel derived from the kinematic wave model. The differences in the lower end points were 4 to 24 hours; in the upper end points, 1 to 8 hours. The uncertainty in the flood arrival time was about 33 hours. (See also W90-05621) (Cassar-PTT)
W90-05703

OPEN CHANNEL FLOW IDENTIFICATION. CASE STUDIES.
Rijkswaterstaat-Deltadienst, Rijswijk (Netherlands). Data Processing Div.
A. W. Heemink, and P. G. J. ten Brummelhuis.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 782-791, 8 fig, 9 ref.

Descriptors: *Flow characteristics, *Hydraulics, *Channel flow, *Open-channel flow, *Model studies, *Estuaries, Mathematical studies, WAKFIL model, St Venant equation, Stochastic process, Friction, Wind, Hydraulic friction, Rhine-Scheldt Channel, Scheldt Estuary, The Netherlands.

The program system WAKFIL, based on the St. Venant equations, was applied to two open-channel flow problems in the Netherlands. Wind stress coefficients, bottom friction coefficients, water levels, and discharges were estimated by using an extended Kalman filter procedure. In the Eastern Scheldt Estuary the bottom friction parameter was found to depend on both the phase and the amplitude of the tide, which was in agreement with published observations. The wind stress coefficient, estimated for a stormy period within a 67% confidence level, was more accurately determined during the strongest winds. In the Rhine-Scheldt channel, which connects two lakes, the WAKFIL program indicated that the bottom friction would be reduced significantly when the dams at both ends were closed. This resulted in a 20% increase in current velocity compared with modeling without the WAKFIL program. (See also W90-05621) (Cassar-PTT)
W90-05704

FORECAST OF STABILITY OF BED LOAD IN UNSTABLE CHANNELS.
Moskovskii Inst. Inzhenerov Zheleznodorozhnogo Transporta (USSR).
For primary bibliographic entry see Field 2J.
W90-05706

POWER LAW OF FLOW RESISTANCE IN OPEN CHANNELS, MANNING'S FORMULA REVISITED.
Geological Survey, Menlo Park, CA.
C. Chen.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 817-848, 2 fig, 4 tab, 73 ref.

Descriptors: *Flow characteristics, *Hydraulics, *Channel flow, *Mannings equation, *Roughness coefficient, *Flow resistance, *Open-channel flow, Open channels, Turbulent flow, Hydraulic roughness, Resistance.

Manning's formula was critically evaluated by addressing important issues in the power formulation of flow resistance. The m-th-power formulas were generally applicable to turbulent flow in open channels, regardless of the stability of the free surface. Manning's equation (1/6-th-power formula) was shown to apply to virtually all possible flows. The method of least squares was used to estimate the values of the coefficient and exponent in the power law. Then the accuracy of Manning's formula was evaluated by computing its variance or standard deviation from the logarithmic formula for various ranges of the relative roughness. For the widest range of relative roughness tested (between 1 and 1000), Manning's formula fit the logarithmic formula within 5% error. (See also W90-05621) (Cassar-PTT)
W90-05708

MANNING FORMULA IN CONTEXT.
University Coll., Dublin (Ireland). Centre for Water Resources Research.
J. C. I. Dooge.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 849-902, 5 tab, 104 ref.

Descriptors: *Flow characteristics, *Open-channel flow, *Hydraulics, *Channel flow, *Mannings equation, *Roughness coefficient, Hydraulic roughness, Flow resistance, Mathematical studies, Ireland, Concentration time, Rainfall-runoff relationships, Pipe flow, Chezy equation, Gauckler formula, Bazin formula, Humphrey-Abbott formula, Kutter formula, Etely-Stearns formula, Revy formula, Nikuradze coefficient.

The Manning formula of 1889 was presented within several contexts: Robert Manning's early background and the flow formulas available for his study, river engineering in Ireland in the mid 1800s, classical experiments on flow by several researchers on flow, derivation of the monomial formula in 1889, and developments since 1889. Manning was influenced by the concepts and traditions which had been developed at the time he began his engineering career. These included the uniform flow concept (1686-1786), the Chezy experiments (1769-1776), and the universal channel flow formulas (1775-1851). His design tables published in 1852 revealed his desire for simplification and ease of computation. In his prolific writings Manning commented on the classical experiments of Darcy on roughness in pipes in 1847-1857, the Darcy-Bazin experiments of 1855-1865 on pipe flow principles applied to open channel flow, the Mississippi Report of 1851-1858, and the Ganguillet-Kutter formula of 1869. After Manning developed the monomial formula, he derived a second dimensionally correct formula as an alternative. The n value was later introduced into the equation, following the example of Kutter's n. Citation of Manning's 1889 paper in the literature began in 1891, and use of the formula spread rapidly during 1919-1959, gradually replacing Kutter's formula. Manning's formula is still widely used in spite of logarithmic-type formulas developed in modern fluid mechanics. A relationship between Manning's n and Nikuradze's k (roughness size) was developed. (See also W90-05621) (Cassar-PTT)
W90-05709

RE-OPERATION OF OLD WATER SYSTEM IN NORTHERN IRAQ.
Institute of Technology, Baghdad (Iraq). Dept. of Irrigation.
S. T. Azzawi, and A. I. J. Hawa.
IN: Proceedings of the International Conference on Channel Flow and Catchment Runoff: Centennial of Manning's Formula and Kuichling's Rational Formula. University of Virginia, Charlottesville, VA. 1989. p 903-909, 1 fig, 2 tab, 8 ref.

Descriptors: *Hydraulics, *Water management, *Channel flow, *Water supply, *Iraq, Sedimentation, Drinking water, Irrigation water, Water storage, Canals, Flood peak, Rational formula, Catchment basins, Kuichlings rational method.

The rational formula was applied to a 1500-year old water collection and storage system in Iraq to estimate peak flow. The system consisted of a catchment basin on which rainfall was conducted to two sloping canals, then to three sedimentation tanks and two storage tanks contained in a conical rock cavity of 2000 cu m capacity with a 80 x 80 cm top opening. After proposed repairs to the ancient system (increasing the canal capacity in the lower reaches and reconstructing the sedimentation tanks), it was expected that the system could supply 20,000 cu m water yearly at a cost less than the cost of groundwater development. (See also W90-05621) (Cassar-PTT)
W90-05710

FIELD MEASUREMENTS OF DIRECTIONAL WAVE LOADS ON COASTAL STRUCTURES.
Rijkswaterstaat, Delft (Netherlands). Road and Hydraulic Engineering Div.

Group 8B—Hydraulics

J. van Heteren, H. C. Botma, and A. P. Roskam.
Applied Ocean Research AOCRDS, Vol. 11, No. 2, p 58-74, April 1989. 15 fig, 3 tab, 14 ref.

Descriptors: *Ocean waves, *Sluice gates, *The Netherlands, *Waves, Hydrodynamics, Loading, Model studies, Regression analysis, Velocity.

Data were collected at the Haringvliet barrier in The Netherlands to verify the theory that wave loading on long structures is considerably reduced if wave directionality is used in the calculations instead of assuming unidirectional long-crest waves. Wave loads were measured with a row of pressure gages at the barrier. The directional parameters of the incoming wave field were calculated from recorded signals of a 3-component acoustic current meter, mounted 7.5 m in front of the barrier. These calculations differed from those used for an open sea, because the waves near a reflecting structure are formed by two highly correlated wave field. A new method of calculating the wave directional parameters of the incoming wave field from the three orthogonal velocity components were developed. It appears to be successful. The results show that the theoretical model for incorporating wave directional properties agrees very well with full scale measurements. The regression coefficient between theoretical and measured values does not differ statistically from the value. (Author's abstract)
W90-05858

WAVE PENETRATION IN HARBOURS BY THE FINITE-ELEMENT SERIES-EXPANSION METHOD.
Bologna Univ. (Italy). Dipt. di Fisica.
F. Mattioli.
Applied Ocean Research AOCRDS, Vol. 11, No. 3, p 135-142, July 1989. 7 fig, 8 ref.

Descriptors: *Harbors, *Ocean waves, *Water circulation, *Waves, Model studies, Morphology, Oscillations.

The finite-element series-expansion technique has been recently introduced to study the propagation of linear surface waves in large regions of sea. In previous applications rectangular domains subdivided into many square elements have been considered, especially to show the main property of the method, i.e. the possibility of dealing with larger regions of sea. Here, another important property of the method is stressed, i.e. the possibility of using elements of arbitrary shape and size. An application to the wave penetration in a harbor points out the simplicity of use of the method. The model points out the strong influence of the geometry of the basins and the nature of the boundaries on the response curves, which prove to be highly sensitive to these factors. The peculiar modes of oscillations of the single basins and their coupling play a fundamental role in the harbor response, and at present can only be investigated by means of a numerical model. (Author's abstract)
W90-05859

MODELLING OF SOME ELLIPTIC FLUID MECHANICS PROBLEMS BY THE BOUNDARY ELEMENT METHOD.
Delaware Univ., Newark. Dept. of Civil Engineering.
S. Grilli.
Advances in Water Resources AWREDI, Vol. 12, No. 2, p 66-73, June 1989. 7 fig, 1 tab, 15 ref.

Descriptors: *Boundary processes, *Finite element method, *Fluid mechanics, *Laplace equation, *Numerical analysis, Differential equations, Groundwater movement, Mathematical models, Ocean waves, Porous media, Saline-freshwater interfaces.

The Boundary Element Method (BEM) is considered one of the leading methods for solving the partial differential equations which mathematically express many practical engineering problems. The BEM is a combination of Boundary Integral Equation (BIE) methods and numerical techniques derived from the Finite Element Method (FEM). The BEM has proved to be a powerful numerical tool when applied to problems in fluid mechanics, particularly when applied to perfect fluid problems (elliptic or Laplace problems). By providing results on the boundaries of a system (particularly moving boundaries such as a phreatic surface, wave free surface, or saltwater interface), the BEM eliminates the need to obtain results inside the fluid domain. The BEM is applied to Laplace problems, linear sea wave modeling, steady state porous media flow, and linear fluid-structure interaction. Although special numerical problems need to be addressed (such as singular integration, discretization, and full matrices), for many problems the solution time of the BEM is up to an order of magnitude faster that the FEM for both two-dimensional and three-dimensional applications. (Tappert-PTT)
W90-05884

MODELLING TIDAL ENERGETICS OF THE COLUMBIA RIVER ESTUARY.
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2L.
W90-05909

WATER WAVES PAST ABRUPT CHANNEL TRANSITIONS.
Delaware Univ., Newark. Dept. of Civil Engineering.
R. A. Dalrymple.
Applied Ocean Research AOCRDS, Vol. 11, No. 4, p 170-175, October 1989. 3 fig, 20 ref.

Descriptors: *Channel flow, *Channel morphology, *Flow models, *Harbors, *Hydraulic design, *Resources management, *Wave propagation, Coastal engineering, Diffraction, Eigenvalue, Mathematical models, Variational method, Water waves, Wave height.

The reduction of wave height by diffraction is an important design factor in locating harbor facilities. The propagation of waves in a narrow channel with an abrupt transition to a wider channel was modeled to determine the reflection coefficients and the diffraction patterns associated with the transition. An eigenfunction expansion method was used for the full range of channel transitions, while a variational solution was developed for the case when only planar waves are reflected in the upwave channel. Significant reflections occur when the wavelength of the waves in the wider channel corresponds to multiples of the channel width. The eigenvalue and variation methods provide an accurate means to determine the reflection from the channel transition. (Brunone-PTT)
W90-06011

FORMED SUCTION INTAKE APPROACH APPURTENANCE GEOMETRY.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. P. Fletcher.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report HL-90-1, February 1990. Final Report. 41p, 3 fig, 3 tab, 23 plates.

Descriptors: *Design criteria, *Hydraulic models, *Hydrodynamics, *Intakes, *Pump testing, *Suction intakes, Flow profiles, Hydraulic properties, Pumps.

Physical hydraulic model tests were conducted to investigate the hydraulic characteristics of a selected formed suction intake (FSI) design subjected to various hydraulic conditions. A variety of pump bay lengths and widths were evaluated. Hydraulic performance was evaluated by measuring flow distribution, swirl angle, and vortex intensity. Test results revealed that the FSI provided satisfactory flow to the pump with adverse flow in the approach. Test results are presented in dimensionless terms in plots and sketches. (Author's abstract)
W90-06202

PHYSICAL TEST FACILITY FOR MODELING OPEN-WATER PLACEMENT OF DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. H. Johnson, M. J. Trawle, and R. W. McCarley.
Army Corps of Engineers Information Exchange Bulletin, Vol. DRP-90-1, January 1990. p 1-4, 1 fig, 3 ref.

Descriptors: *Dredging, *Fate of pollutants, *Hydraulic models, *Path of pollutants, *Physical models, Dredging wastes, Model studies, Waste disposal.

To obtain data to guide numerical model refinements for predicting the short-term fate of dredged material placed in open waters, laboratory experiments of various placement operations are being conducted at the Army Corp of Engineers' Waterways Experiment Station. An investigation into appropriate scaling laws resulted in the conclusion that at model-to-prototype scales greater than 1:100, physical model studies can be reasonably scaled to prototype phenomena. Therefore, results from the model studies can be used to provide an increased understanding of the physical processes that occur during the open-water placement of dredged material. (Lantz-PTT)
W90-06206

8C. Hydraulic Machinery

EXPERIENCE IN THE OPERATION AND ADJUSTMENT OF ELECTROHYDRAULIC GOVERNORS OF HYDRAULIC TURBINES.
A. A. Pimburgskii.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 153-157, March 1989. 4 fig, 2 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 31-34, March, 1989.

Descriptors: *Control systems, *Hydraulic machinery, *Hydraulic turbines, *Turbines, Electrohydraulic governors, Floating control devices, Hydromechanical governors.

Six modifications of electrohydraulic governors (EHGs) differing not only in basic design but also in the block diagram are presently operating at Soviet and foreign hydroelectric stations along with hydromechanical governors. One of the differences between the floating control device in an EHG and the dashpot in hydromechanical governors is the absence of limitation on the action of the RC output signal on the EHG. This results in the need for an automatic device that eliminates the consequences of this characteristic. However, the uncoordinated or untimely action of these automatic devices may cause system malfunctions. Two electrohydraulic governors, the EGRK-2M and the EGRK-1T, have been developed to correct this problem. Experience in operating and adjusting these governors shows that it is possible to greatly improve the characteristics of the control system and to increase the operating reliability of the governors by uncomplicated improvements in the circuit of the automatic devices floating control systems. (White-Reimer-PTT)
W90-06130

USE OF ELECTRICAL BRAKING OF UNITS AT HYDROELECTRIC STATIONS WHEN DROPPING THE LOAD.
N. N. Arshenevskii, and G. G. Sotnikov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 158-161, March 1989. 4 fig, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 34-36, March, 1989.

Descriptors: *Electrical braking, *Electrical equipment, *Hydraulic machinery, *Hydroelectric plants, Control systems, Gates, Hydraulic equipment, Water hammer.

At hydroelectric stations with a high-inertia pressure system, one of the means of reducing water hammer is to slow the closing of the gate apparatus. However, the rotational speed when dropping the load can exceed the mechanical strength of the generator. A method for determining the electrical braking system parameters and its effect on fluid mechanical transients after dropping the load was

examined for a hydrostation with long intake works and mixed-flow turbines. Even though the runaway speed exceeds the rated by almost 2 times, closing of the gate apparatus provides acceptable water hammer values. The temporary speed increase of the unit can reach 90%. It was determined that electrical braking on the process of dropping the load was effective from the viewpoint of fluid mechanics phenomena. One virtue of electrical braking is the simplicity of controlling the electrical power which makes it possible to control the braking torque and the entire transient. In order to implement the method, it is necessary to develop a scheme for controlling the electrical braking system, and select the appropriate electrical resistances and other electrical equipment. (White-Reimer-PTT)
W90-06131

USE OF THE DANUBE RIVER AND THE INTEGRATED GABCIKOVO-NAGYMAROS HYDRO DEVELOPMENT PROJECT.
Y. S. Vasilev, and G. A. Pretro.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 171-176, March 1989. 3 fig, 2 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 51-54, March, 1989.

Descriptors: *Danube River, *Hydroelectric plants, *Water resources development, Czechoslovakia, Gabcikovo-Nagymaros hydro project, Hungary, Reservoirs, River basin development, River systems, Water resources management.

An overview of the uses of the Danube River along with the specifications for the Gabcikovo-Nagymaros Hydro Development project are presented. The Danube is located in the territory of eight European countries and is important as a means of transport, for international shipping, and for hydroelectric power. On the basis of 25-yr surveys, investigations, and negotiations, in 1977 Czechoslovakia and Hungary signed an agreement for a joint hydro development project. The main part consists of two hydro developments, the Gabcikovo and Nagymaros. The system will encompass a 220 km stretch of the Danube with 142 km along the Czechoslovakia and Hungary border. The joint construction of the upper Gabcikovo reach began in 1978 and the lower Nagymmaros in 1984. The Drushov-Dunakiliti reservoir created on the Danube by the Dunakiliti dam with an area of 60 sq km and a length of about 30 km will be located near Bratislava. Its useful storage at a pool level to elevation 131.2 m will be 197.5 million cu m and the useful storage at drawdown by 1.0 m will be 49 million cu m. This storage provides daily regulation of river discharge. (White-Reimer-PTT)
W90-06134

FORMED SUCTION INTAKE APPROACH APPURTENANCE GEOMETRY.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-06202

8E. Rock Mechanics and Geology

ENGINEERING GEOLOGY OF THE RENO-LAKE TAHOE AREA, NEVADA.
Nevada Bureau of Mines and Geology, Reno.
J. W. Bell, R. J. Watters, and P. A. Glancy.
IN: Engineering Geology of Western United States Urban Centers. Los Angeles, California to Denver, Colorado, June 27-July 7, 1989. American Geophysical Union, Washington, DC. Field Trip Guidebook T181, (1989). p 41-50, 18 fig, 14 ref.

Descriptors: *Urban hydrology, *Nevada, *Geohydrology, *Lake Tahoe, *Engineering geology, *Floods, Lake Price, Landslides, Reno.

Reno is located at the western edge of the Great Basin province along the foot of the Sierra Nevada. The varied geology, hydrology, and physiography of the area contribute to a wide range of engineering geologic conditions which can significantly influence land-use considerations in this rapidly growing urban area. Although there are numerous engineering geology topics of interest-including expansive soils and groundwater resources--this study focuses on several of the more important, and interesting, aspects: earthquake hazards of the Reno-Carson City urban corridor; slope stability characteristics of the Reno-Lake Tahoe area, including the 1983 landslide and associated waterflood at Slide Mountain; and surface runoff characteristics in the Lake Tahoe area. Five principal creeks in the Incline Village area, First Creek, Second Creek, Wood Creek, Third Creek, and Incline Creek have a cumulative drainage of 46 sq km and furnish a yearly average of about 18.5 cu hectometers of runoff to Lake Tahoe. For the 4 year period 1970-1973, annual runoff from the individual streams ranged from 0.567 to 8.717 cu hectometers, and discharges ranged from 0.0057 to 3.1 cu m/sec. During the 4 years, the five streams delivered about 28,000 metric tons of sediment, which averaged about 75% gravel and sand, 15% silt, and 10% clay, to the lake. Annual quantities ranged from 1,360 to 9,980 tons. The 1982/83 winter was noted for a record snow pack in the Sierra Nevada. At mid-day of May 30, 1983, a large mass of rock detached from the southeast side of Slide Mountain, NV. The lowest part of the slide entered Upper Price Lake, a small reservoir. The sudden movement of landslide debris into the lake created a surge of water that rapidly exited the pond and flowed into Lower Price Lake. This wave of water immediately flushed Lower Price Lake, and the cumulative contents of both lakes, about 0.025-0.037 cu hectometers of muddy water, rushed down the steep canyon of Ophir Creek below the lakes. After about 8-9 minutes of travel, this debris wave, with a leading edge about 9 m high, reached the canyon mouth where the channel abruptly widened and flattened. At the canyon mouth, the boulder-laden flood wave encountered and destroyed 2 homes. Maximum depth of fill across an old roadway was about 2.7 m. (Lantz-PTT)
W90-05736

PALYGORSKITE-SEPIOLITE.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-05748

PHASE II GDM ON THE SANTA ANA RIVER MAINSTEM INCLUDING SANTIAGO CREEK. VOLUME 3: LOWER SANTA ANA RIVER, APPENDIXES.
Army Engineer District, Los Angeles, CA.
For primary bibliographic entry see Field 8A.
W90-05757

8F. Concrete

EVALUATION OF POLYESTER RESIN, EPOXY, AND CEMENT GROUTS FOR EMBEDDING REINFORCING STEEL BARS IN HARDENED CONCRETE.
Singleton Materials Engineering Labs., Knoxville, TN.
For primary bibliographic entry see Field 8G.
W90-05742

SUBSTANTIATION OF THE TIERED TECHNOLOGY OF CONSTRUCTING ARCH DAMS.
U. S. Gunter, A. S. Danilov, V. A. Shilov, and M. V. Shchelkanova.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 127-130, March 1989. 7 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 11-14, March, 1989.

Descriptors: *Arch dams, *Concrete construction, *Concrete dams, *Concrete technology, *Dam construction, Concrete mixes, Concretes, Cracking, Miatla Dam, Temperature effects, Tiered construction, USSR.

It has been established that thermal stress is the main cause of cracking in concrete blocks; however, the problem of prevention has not been completely solved. Several dams in the Soviet Union were studied to address this problem. It was observed that cracks were not found in sections of the Bukhtarma Dam when the long blocks were under a shelter that protected the block faces from the outside air and provided slow cooling of the concrete. An analysis of Chirkey Dam (USSR) indicated that parameters such as the temperature of the concrete mix, maximum temperature of the concrete in the blocks, and differences between the temperatures in the core and on the surface of the block are important factors in controlling cracking. However, these conditions are difficult to satisfy simultaneously. On the basis of the principles for preventing cracking formulated as a result of the comprehensive study of previous construction experience, a fundamentally new 'tiered' technology for constructing the Miatla Hydroelectric Station arch dam was developed. The tiered method is: (1) not limited to one layer, but can have two or more layers in the block; and (2) temperature regulated by means of an internal cooling pipe used in combination with the periodic placement of temporary heat protectors for the external faces, that equalize the temperature field of the dam and the differences between the external and internal temperature. (White-Reimer-PTT)
W90-06124

REGULATION OF THE TEMPERATURE REGIME OF CONCRETE IN THE TIERED TECHNOLOGY OF CONSTRUCTING AN ARCH DAM.
Y. S. Gunter, A. S. Danilov, V. A. Redkin, and M. V. Shchelkanova.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 130-134, March 1989. 2 fig, 2 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 14-16, March, 1989.

Descriptors: *Arch dams, *Concrete construction, *Concrete dams, *Concrete technology, *Dam construction, Concretes, Cracking, Miatla Dam, Regulations, Temperature effects, Tiered construction, USSR.

A method for constructing arch dams without cracks was demonstrated by the technique used in the construction of the Miatla hydrostation. The prevention of cracking was achieved not by more stringent temperature requirements and an increase in regulations, but as a result of a fundamental change in the technology which also reduced the regulation costs. The technique used allowed an increase in the temperature of the concrete mix to 23 C, a maximum concrete temperature of 45 C, an increase of the cooling rate of concrete in the period after the temperature peak to 2 C/day, and an increase in the rate of growth of the dam in height to 8 m/month. For tiered technology construction the time of block covering, continuous pipe cooling, and insulation of the faces from temperature shock are of primary importance for crack prevention. The success of the Miatla dam construction indicates that removing restrictions on the rate of growth of structure height, temperatures of mix and concrete, cooling rates and block dimensions should be considered. (White-Reimer-PTT)
W90-06125

REINFORCED-CONCRETE PANELS FOR FORMING GROUT JOINTS AS AN ELEMENT OF TIERED TECHNOLOGY.
I. V. Artemev, A. S. Danilov, V. N. Dvurekov, and A. V. Evseev.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 134-138, March 1989. 2 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 17-19, March, 1989.

Descriptors: *Concrete construction, *Concrete dams, *Concrete technology, *Construction joints, *Dam construction, *Reinforced concrete, Arch dams, Construction standards, Grouting, Miatla Dam, USSR.

A new tiered method of construction was introduced in the building of the Miatla Hydroelectric

Station, USSR. The main elements of this method are: (1) concreting of the dam with horizontal tiers from bank to bank; (2) successive concreting of the blocks of adjacent sections separated by a joint between the sections; and (3) no interruptions for hardening the concrete, removing the forms from the surface of joints, installing cement grouting pipes and outlets, and sealing of the joints being grouted. Two variations were examined for forming the surface of the joint from precast panels. The first method formed the joint surface from rectangular panels of one or two types placed in the middle, offset part of the joint, with additional (add-on) panels of variable width placed on segments of the joints connecting the main panels with the faces of the dam. The second method formed the joint surface from panels in the form of a trapezoid, the side surfaces of which are parallel to the upstream and downstream faces of the dam; the bases have a length equal to the thickness of the arch at the given elevation. Since the thickness of the arch varies from 11.5 to 6.3 m, all slabs forming the joint have a different base length and variable slope along the sides. The second method was employed for the Miatla station. In addition to developing the design of the joints and reinforced concrete panels, the work program included the creation of molds for manufacturing the panels; manufacturing and testing experimental specimens; tryout of structural elements of the joints, technology of manufacture, and installation of the panels on experimental articles and fragments of the section joint; and, investigation under actual conditions for the quality of the surface obtained, opening and passability of the joints, cohesion of the reinforced concrete panels with the in situ concrete, and other characteristic indices. (White-Reimer-PTT)
W90-06126

MONITORING DURING CONSTRUCTION OF THE MIATLA DAM.
For primary bibliographic entry see Field 8G.
W90-06127

EFFECT OF THE MAXIMUM SIZE OF COARSE AGGREGATE ON THE MAIN PARAMETERS OF CONCRETE.
A. M. Ibragimov.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 141-144, March 1989. 4 fig, 2 tab, 8 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 22-24, March, 1989.

Descriptors: *Concrete construction, *Concrete technology, *Construction materials, Aggregates, Concrete additives, Concrete mixes, Particle size.

The effect of aggregate size on the properties of concrete is complex and has not been well studied. It has been demonstrated that an increase in the maximum diameter of coarse aggregate allows a reduction in the water and cement content in concrete, reduces volume deformations from shrinkage, and increases density. However, an increase in the aggregate size also results in an increase in concrete mix segregation during transport and placement, increases wear on concrete mixers, and complicates the compaction of the concrete mix. In the course of constructing a hydroelectric station in the Sulak River basin, concrete with a maximum aggregate size of 80 mm was investigated and compared with results for concrete with a maximum aggregate size of 40 mm. It was found that for 80 mm aggregate: (1) the consumption of cement decreases by 20-30 kg/cu m, and the density of the concrete mix increases; (2) concretes with a water/cement ratio from 0.40 to 0.68, the compressive strength increases insignificantly (up to 9%) and the splitting strength decreases up to 10%; and (3) a decrease of the tensile strength, accompanied by an increase of the elasticity modulus, led to a substantial decrease of the ultimate extensibility of concrete (up to 28%), which occurs as a result of an increase of the inhomogeneity of the concrete and decrease of the cohesive strength of the aggregate with the hardened cement. It was concluded that the limiting value of the maximum size of aggregate should be selected on the basis of the fractional composition of natural deposits planned to be used for obtaining aggregates with consideration of their rational use and the design characteristics of the structures and feasibility study. (White-Reimer-PTT)
W90-06128

CHARACTERISTICS OF THE CONSTRUCTION OF ARCH DAMS ON THE SULAK RIVER.
A. S. Danilov, V. N. Dvurekov, and V. I. Zholnerchuk.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 145-147, March 1989. 2 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp. 24-26, March, 1989.

Descriptors: *Arch dams, *Concrete construction, *Concrete dams, *Concrete technology, *Dam construction, Cement mixes, Construction standards, Miatla Dam, Sulak River, Temperature, USSR.

The construction of the first high arch dam at the Chirkey Hydroelectric Station in the USSR raised a number of problems related to developing efficient construction methods that combine quality work with the building of a unique structure. The possibility of using ordinary high-alite cements for arch dams was demonstrated by investigations of the heat liberation of cements, and by a comparative analysis of the maximum temperature of the Chirkey and Miatla dams concrete. Underlying the development of the technology for the Miatla dam construction were ideas of uniform dam construction with successive placement of concrete blocks from bank to bank without leading and lagging sections with a work cycle on the concreting tier of not more than 7 days; active regulation of the temperature regime of the concrete by intense pipe cooling in combination with thermal protection of the external faces; better achievement of the highly mechanized Chirkey method; and formation of a helicoid surface of the joints between sections by permanent reinforced-concrete panels containing grouting fittings and groutstops. The tiered technology is applicable only under conditions of high-speed construction. Any deviation from the principles underlying this technology can lead to the formation of cracks. Before starting concreting operations, the concrete facilities should be completely ready, the methods of performing the works and regimes of regulating the temperature of the concrete should be worked out, a construction monitoring service should be organized, and the monitoring means should be developed. Successful completion of the construction of the Chirkey and Miatla arch dams, and their normal behavior under a load indicate the possibility of wide use of this economical class of retaining structures. (White-Reimer-PTT)
W90-06129

SPALL REPAIR OF WET CONCRETE SURFACES.
Singleton Materials Engineering Labs., Knoxville, TN.
J. F. Best, and J. E. McDonald.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report REMR-CS-25, January 1990. Final Report. 33p, 17 fig, 9 tab, 6 ref. DOE Contract WESSC-85-05/TV-67769A.

Descriptors: *Concrete repair, *Concretes, *Hydraulic structures, *Maintenance, Abrasion, Bonding, Epoxy resins, Freeze-thaw tests, Strength.

Because of the nature of the hydraulic structures over which the Corps of Engineers has responsibility, there are frequent requirements to repair spalled or eroded concrete that is underwater, close to the waterline, or in areas from which it is difficult to divert flow or dry the concrete. An investigation was conducted to evaluate the effectiveness of commercially available products in repair of concrete with wet surfaces. Slant-shear bond and compressive strength tests were conducted on each of the 22 materials recommended for repair of spalls in wet concrete. Based on the results of these screening tests, eight materials were selected for additional laboratory tests including: (1) bonding capacity in direct tension; (2) bonding capacity under flexural stress; (3) resistance to abrasion; (4) resistance to cycles of freezing and thawing; (5) impact resistance; and (6) thermal compatibility with concrete. Test results and material costs were used in developing a rating system to compare the relative performance of the various materials. Overall performance ratings indicate two materials, an epoxy and a cement-based product, were nearly equal in outperforming the other products tested. Which of these two materials to be specified for a given repair will likely depend on the specific project requirements and critical material properties. (Author's abstract)
W90-06219

8G. Materials

EVALUATION OF POLYESTER RESIN, EPOXY, AND CEMENT GROUTS FOR EMBEDDING REINFORCING STEEL BARS IN HARDENED CONCRETE.
Singleton Materials Engineering Labs., Knoxville, TN.
J. F. Best, and J. E. McDonald.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report REMR-CS-23, January 1990. Final Report. 63p, 30 fig, 16 tab, 3 ref.

Descriptors: *Polyester resin, *Resins, *Epoxy resins, *Cements, *Grouting, *Concrete technology, *Materials testing, *Reinforced concrete, Steel, Creep, Hydraulic structures.

Rehabilitation of hydraulic structures usually includes removal and replacement of deteriorated concrete. Dowels are normally used to anchor the new concrete to the existing concrete and to position vertical and horizontal reinforcing steel in the replacement concrete. An investigation was conducted to evaluate the effectiveness of cement, epoxy, and polyester resin grouts used to embed reinforcing steel bars in hardened concrete under a variety of placing and curing conditions. The following parameters were determined for each grout: (1) physical characteristics of the grouts, (2) effects of temperature and moisture on early service performance, (3) long-term pullout strength under varying curing conditions, (4) creep strain of grout under sustained loading in both wet and dry environments, and (5) effects of hole roughness and cleanliness on grout performance. With the exception of the polyester resin grout placed under submerged condition, pullout strengths were essentially equal to the ultimate strength of the anchor when the grouts were placed under wet or submerged conditions. The overall average pullout strength of polyester resin grout placed and cured under submerged conditions was 35% less than the strength of the same grout placed and cured under dry conditions. The largest reduction in pullout strength, approximately 50%, occurred at ages of 6 months and 16 months. Polyester-resin-grouted anchors exhibited significantly higher creep than that exhibited by epoxy-, and cement-grouted anchors under both wet and dry conditions. Consequently, creep data should be considered in the selection of an anchorage grout where the frictional resistance and bond between the surfaces of the two masses to be anchored together are important. Although the epoxy grout performed well in these tests when placed in wet holes, it should be noted that the manufacturer does not recommend placement under submerged conditions. (Lantz-PTT)
W90-05742

MONITORING DURING CONSTRUCTION OF THE MIATLA DAM.
G. M. Drozdov, E. G. Levchenko, M. V. Shchelkanova, and G. K. Skripitsyn.
Hydrotechnical Construction HYCOAR, Vol. 23, No. 3, p 138-140, March 1989. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 3, pp.20-21, March, 1989.

Descriptors: *Concrete construction, *Concrete dams, *Dam construction, *Measuring instruments, *Monitoring, *Quality control, Construction joints, Miatla Dam, Temperature, USSR.

In order to monitor the construction of the Miatla Dam, USSR, which used the new tiered technology, a large number of monitoring and measuring instruments were installed in the dam. These instruments included a 140 DDShch-6 remote gap meters and 470 PPT-60 thermistor temperature transducers. The temperature transducers were installed in 135 of the 290 blocks at a height of 1.5 m with from 1-14 instruments in a block. The gap meters were installed at one or two sites in each grouting segment in all section joints with 1 to 3 instruments in a block. At the time the grouting segments were sealed, from 50 to 88% of the temperature transducers and from 40 to 80% of the gap meters were still operating. In addition a new instrument was developed for measuring the deformation of the joints. The measurement and calculation time was 10-12 sec and the maximum error was 50 micron with a measurement range of 7 mm. It was concluded that the organization of the monitoring program during construction promoted the successful solution of the problem of accelerated construction and sealing of the Miatla Dam. (White-Reimer-PTT)
W90-06127

DESIGN, CONSTRUCTION, AND EVALUATION OF CLAY LINERS FOR WASTE MANAGEMENT FACILITIES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste and Emergency Response.
For primary bibliographic entry see Field 5E.
W90-06163

8I. Fisheries Engineering

BIBLIOGRAPHY OF FISHERY INVESTIGATIONS ON LARGE SALMONID RIVER SYSTEMS WITH SPECIAL EMPHASIS ON THE BOIS BRULE RIVER, DOUGLAS COUNTY, WISCONSIN.
Wisconsin Dept. of Natural Resources, Madison.
For primary bibliographic entry see Field 10C.
W90-05735

FISHERIES-OCEANOGRAPHY COORDINATED INVESTIGATIONS--FIELD OPERATIONS 1988.
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
P. D. Proctor.
NOAA Data Report ERL PMEL-25, October 1989. 69p, 19 fig, 10 tab, 9 ref.

Descriptors: *Fisheries, *Bering Sea, *Oceanography, *Alaska, Pollock, Shelikof Strait, Fish populations, Conductivity, Water temperature, Biological studies, Water currents, Ocean circulation.

Begun in 1984 as the Fisheries-Oceanography Experiment (FOX), 1988 marks the third field year of the Fisheries-Oceanography Coordinated Investigations (FOCI). The current goal of FOCI is to understand the processes that influence the life-cycle and recruitment of walleye pollock into the Shelikof Strait fishery and enable projections of fish abundance prior to recruitment into the fishing stock. FOCI also incorporates research being done in the Bering Sea by the Recruitment Investigations in the Bering Sea (RIBS) projects. FOCI is a joint project of the Pacific Marine Environmental Laboratory (PMEL) and Northwest and Alaska Fisheries Center (NWAFC). Investigators from several universities and research facilities are also involved in the project. FOCI-88 involved five ship cruises that continued long-term time series of Conductivity/Temperature/Depth (CTD) data; biological and chemical sampling; and studies of currents using moored current meters, ship-mounted Acoustic Data Current Profilers (ADCP) and drifting buoys. Oceanographic sampling was primarily done using a grid system originally devised for the FOX project. RIBS stations follow no standard grid pattern. The ships also recovered current meter moorings deployed during the previous field season and deployed new moorings. FOCI-88 also continued the weather monitoring that was begun in 1984 and expanded in 1986 and 1987. The number of weather stations was reduced at the end of 1988. A description of the equipment and methods that were used during the 1988 FOCI field season is presented. (Lantz-PTT)
W90-05737

RESPONSE OF SPORT FISHES TO THERMAL DISCHARGES INTO THE GREAT LAKES: IS SOMERSET STATION, LAKE ONTARIO, DIFFERENT.
State Univ. of New York Coll. at Brockport. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-05855

SPECIES COMPOSITION AND BIOMASSES OF FISHES IN DIFFERENT HABITATS FOR A TROPICAL NORTHERN AUSTRALIAN ESTUARY: THEIR OCCURRENCE IN THE ADJOINING SEA AND ESTUARINE DEPENDENCE.
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.
For primary bibliographic entry see Field 2L.
W90-05908

FATE OF FRESHWATER MUSSELS TRANSPLANTED TO FORMERLY POLLUTED REACHES OF THE CLINCH AND NORTH FORK HOLSTON RIVERS, VIRGINIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences.
For primary bibliographic entry see Field 5G.
W90-05928

ROLE OF HYDRODYNAMIC STIMULI IN THE BEHAVIOR AND ORIENTATION OF FISHES NEAR OBSTACLES.
Akademiya Nauk SSSR, Moscow. Inst. of Evolutionary Morphology and Animal Ecology.
D. S. Pavlov, and S. N. Tyuryukov.
Journal of Ichthyology JITHAZ, Vol. 29, No. 1, p 96-107, 1989. 6 fig, 1 tab, 21 ref.

Descriptors: *Fish behavior, *Flow around objects, *Hydrodynamics, *Water currents, Fish guiding, Fish management, Fish physiology, Orientation.

Hydrodynamic perturbations can convey information, without light radiation, about the presence of obstacles in the space surrounding a fish. These obstacles create conditions for the use of the lateral line and the semicircular canals in orientation. The existence of a hydrodynamic mechanism of orientation in space is demonstrated in Percidae and Cyprinidae by the coincidence of distance of hydrodynamic perturbations created by the movement of the fish and various other objects in standing water or by immobile objects in a current. The hydrodynamic perturbations carry information to the fish about the presence of obstacles and cause an avoidance reaction. Juvenile fish carried by the current avoid the areas with a negative longitudinal gradient in the dark and also avoid zones of high velocities. Rheotaxis is important for regulating fish behavior, and can be used in the planning of fish protection structures. (Brunone-PTT)
W90-06017

REPRODUCTION OF THE AZOV-DON SHAD FOLLOWING REGULATION OF THE DON RIVER.
Azovskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva, Rostov-na-Donu (USSR).
I. F. Kovtun, and I. M. Nikulshin.
Journal of Ichthyology JITHAZ, Vol. 29, No. 4, p 43-49, 1989. 2 fig, 8 tab, 4 ref.

Descriptors: *Dam effects, *Regulated flow, *Shad, *Spawning, *Stream fisheries, Anadromous fish, Fish migration, Hydroelectric plants, Navigation channels.

Before regulation of the Don River, stocks of the Azov-Don migratory shad, Alosa pontica pontica, were as high as 14,000 to 15,000 tons, and the mean annual catch was 5000 to 6000 tons. The spawning run of shad into the Don in 1979-1986 began, as in previous years, during the last five days of April at water temperatures of 8-10 C> The run peaked during May 6 to 20 when water temperature in the river had increased to 14-15 C. The main spawning areas were channel areas with a fast current (0.6 to 0.6 meters per second) and depths of 5-11 meters between Kochetovskaya and Arpachin. Following construction of dams the shad spawning grounds were reduced by approximately 120 kilometers. The highest egg mortality was noted in parts of the river where flow velocity was less than 0.4-0.5 meters per second, and also in the navigation channel due to the effect of high speed vessels. The survival rate from egg to juvenile is directly related to the volume of river discharge in May-June (r = 0.94 plus or minus 0.08). The year-class strength in 1979-1986, as indicated by lampara net surveys in August, was at an extremely low level, averaging 337 million for the period, compared to 849 million for the period before regulation (1935-1951) and 748 million for the twenty-year period (1952-1971) following completion of the construction of the Tsimlyansk hydrosystem. (Author's abstract)
W90-06018

SWIMMING BEHAVIOR AS AN INDICATOR OF SUBLETHAL TOXICITY TO FISH.
Fish and Wildlife Service, Columbia, MO.
For primary bibliographic entry see Field 5C.
W90-06045

FISH BEHAVIOR AND ENVIRONMENTAL ASSESSMENT.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5A.
W90-06050

PREFERENCE/AVOIDANCE TESTING OF WASTE DISCHARGES ON ANADROMOUS FISH.
For primary bibliographic entry see Field 5C.
W90-06052

LETHAL EFFECTS OF DRAINING ON BROWN TROUT. A PREDICTIVE MODEL BASED ON FIELD AND LABORATORY STUDIES.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon (France).
For primary bibliographic entry see Field 6G.
W90-06073

ROANOKE RIVER WATER FLOW COMMITTEE REPORT. A RECOMMENDED WATER FLOW REGIME FOR THE ROANOKE RIVER, NORTH CAROLINA, TO BENEFIT ANADROMOUS STRIPED BASS AND OTHER BELOW-DAM RESOURCES AND USERS.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 4A.
W90-06185

9. MANPOWER, GRANTS AND FACILITIES

9C. Research Facilities

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSOURI, FISCAL YEAR 1989.
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06244

9D. Grants, Contracts, and Research Act Allotments

NATIONAL RESEARCH PROGRAM OF THE WATER RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY, FISCAL YEAR 1988.
Geological Survey, Reston, VA. Water Resources Div.
Available from Books and Open File Report Section, USGS Box 25425, Denver, CO 80225. USGS Open-File Report 89-250, 1989. 240p. Compiled by L. C. Friedman and C. N. Donato.

Descriptors: *Research, *Water resources research, *Geological Survey, Research priorities, Grants, Ecology, Groundwater quality, Water chemistry, Sediment transport, Geomorphology, Surface water, Geohydrology, Hydrology.

The National Research Program (NRP) of the US Geological Survey's Water Resources Division (WRD) had its beginnings in the late 1950's when 'core research' was added as a line item to the Congressional budget. Since that time, the NRP has grown to encompass a broad spectrum of scientific investigations. The sciences of hydrology, mathematics, chemistry, physics, ecology, biology, geology, and engineering are used to gain a fundamental understanding of the processes that affect the availability, movement, and quality of the Nation's water resources. The NRP is located principally in Reston, VA, Denver, CO, and Menlo Park, CA. The NRP is subdivided into six disciplines as follows: (1) Ecology; (2) Geomorphology and Sediment Transport; (3) Groundwater Chemistry; (4) Groundwater Hydrology; (5) Surface Water Chemistry; and (6) Surface Water Hydrology. The report provides current information about the NRP on an annual basis. Organized by the six research disciplines, the volume contains a summary of the problem, objective, approach, and progress for each project that was active during fiscal year 1988. Bibliographic information is included with each project summary in the form of reports published between April 1987 and May 1988. (Lantz-PTT)
W90-05744

FISCAL YEAR 1988 PROGRAM REPORT (MISSISSIPPI WATER RESOURCES RESEARCH INSTITUTE).
Mississippi State Univ., Mississippi State. Water Resources Research Inst.
M. T. Bond.
Available from National Technical Information Service, Springfield, VA 22161 as PB89-237242. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1571-01, July 1989. 22p. USGS Contract 14-08-0001-G1571. USGS Project G1571-01.

Descriptors: *Information transfer, *Mississippi, *Research, *Training, *Water resources Institutes, Education, Projects.

During 1988 the Institute's planning activities and research program addressed major issues in Mississippi. Water management planning is a top priority issue. The need for adequate groundwater management plans for some areas and total water management plans for the entire state have been identified as critical. Other areas of importance are ground and surface water quality, erosion and sedimentation, and flow plan management. G1571-02: The objective of this project is to develop a physically based methodology which will determine the fate of agricultural sediment transport through streams and lakes. The project is developing two water quality computer simulation models. The first will be used primarily in determining water quality in streams and lakes. The second focuses on small catchments for the detailed study of the interaction between transport processes. G1571-03: The objective is to assess the effect of 30 years of annual flooding on the vegetative composition and productivity of two Green Tree reservoirs (GTR's). Preliminary findings imply that the initiation, date, water depth at initiation, and duration of water drawn down may be critical in defining long term productivity and species composition of GTR management areas. G1571-04: The objectives were to describe the hydrology of the neogene aquifer system in Jones, Forest, and Lamar Counties in South Mississippi, to document the historic lowering of potentiometric surfaces, and to develop three dimensional, steady state models to predict future aquifer performance. G1571-07: This research will help policy makers identify social and economic barriers to farmers' adoption of conservation technologies. G1571-08: A literature review of drought-emergency management strategies has yielded an extensive bibliography from which a questionnaire was constructed to develop a prototype water use plan for short-term droughts and emergencies. G1571-22: This project supported dissemination of research results, response to requests for information, coordination of the Mississippi water resources conference. G1571-32: This project provides information management support agency in assessing pumping records, mathematical modeling of multi layers in the aquifers underlying northeast Mississippi, and computations for assessment of groundwater resources for permitting and management purposes. (USGS)
W90-06235

FISCAL YEAR 1988 PROGRAM REPORT (CALIFORNIA WATER RESOURCES CENTER).
California Univ., Riverside. Water Resources Center.
H. J. Vaux.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-138595/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1550-01, July 1989. 36p, 3 tab, 1 fig. USGS Contract 14-08-0001-G1550. USGS Project G1550-01.

Descriptors: *California, *Information transfer, *Research, *Training, *Water resources Institutes, Education, Projects.

A synopsis is presented of the result of research projects sponsored under Grant No. 14-08-0001-G1550, the 1988 Water Research Institute Program (WRIP) for the University of California Water Resources Center. It also contain summaries of water problems and issues in California and the Water Resources Center's Program Goals and Priorities, Information Dissemination Activities and Cooperative Arrangements. The California WRIP package is a subset of the Center's overall research program and consists of five projects investigating the following topic areas: Supercritical Fluid Regeneration of Spent Carbon Adsorbent, Evaluation of Evaporation Ponds for Saline Drainage Waters, Wetland Treatment of Urban Runoff, Physics-based Stochastic Description of Overland Flows Due To Excess Applied Irrigation Water Over an Infiltrating Agricultural Region, and Optimal Conjunctive Use Model for Managing Water Supply Systems. (USGS)
W90-06240

FISCAL YEAR 1988 PROGRAM REPORT (GUAM WATER RESOURCES RESEARCH INSTITUTE).
Guam Univ., Agana. Water and Energy Research Inst. of the Western Pacific.
S. Khosrowpanah.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-138587/AS. Price codes: A03 in paper copy, A01 in microfiche. Report G1557-01, July 1989. 24p. USGS Contract 14-08-0001-G1557. USGS Project G1557-01.

Descriptors: *Guam, *Information transfer, *Research, *Training, *Water resources Institutes, Education, Projects.

An overview of the Fiscal Year 1988 research and information transfer activities accomplished by the University of Guam Water and Energy Research Institute is give. These activities were sponsored by the Water Research Institute Program of the U.S. Geological Survey and include the following completed projects: (1) A Study of Soil Erodibility Factors for Guam Watersheds (Phase I); (2) Loss of Freshwater from Aquifer and Storm Water Discharge to the Coastal Zone of Guam; (3) A Study of the Behavioral Effects of Modern Water Storage and Disposal Systems on Atoll Island Groundwater Quality; (4) Applicability of New Recreational Water Quality Standards to Freshwaters in Guam; and (5) Assessment of Waste Disposal on Water Resources in Guam Resources in Guam and Micronesia and Related Quality Studies. (USGS)
W90-06241

FISCAL YEAR 1988 PROGRAM REPORT (ALABAMA WATER RESOURCES RESEARCH INSTITUTE).
Auburn Univ., AL. Water Resources Research Inst.
J. F. Judkins.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-138603/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1508-01, July 1989. 27p. USGS Contract 14-08-0001-G1508. USGS Project G-1508-01.

Descriptors: *Alabama, *Information transfer, *Research, *Training, *Water resources Institutes, Education, Projects.

Alabama's Water Resources Research Institute at Auburn University provided support for four research projects. The program focuses on research and training that is responsive to identified priority problems of the State and Region. Project No. 02 deals with the development of a filter to remove pesticides and other organic pollutants from water supplies. Project No. 03 is the first year of a project to develop a novel industrial wastewater treatment process for paper mill bleach plant effluent. Project No. 04 looks at a common and costly problem in municipal wastewater treatment plants; the disruption of settleability caused by sludge/biomass adsorption to polymers when they are used as flocculants. Since more of the financial incentives must come out of operating costs while maintaining or improving the quality of treatment processes, Project No. 05 looks at the impact of recent changes in Federal tax laws on consideration of privatization of municipal wastewater treatment facilities. The Institute remains active in a modest information transfer program, development of support from a variety of extramural sources, and the work of the newly established Alabama Water Resources Study Commission. (USGS)
W90-06242

FISCAL YEAR 1988 PROGRAM REPORT (NEW HAMPSHIRE WATER RESOURCES RESEARCH CENTER).
New Hampshire Univ., Durham. Water Resources Research Center.
T. P. Ballestero.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-138611/AS. Price codes: A03 in paper copy, A01 in microfiche. USGS Contract 14-08-0001-G1576. USGS Project G1576-01.

Descriptors: *Information transfer, *New Hampshire, *Research, *Training, *Water resources Institutes, Education, Projects.

The report covers the activities of the New Hampshire Water Resources Research Center for the period of July 1, 1988 through June 30, 1989. The results of five research projects are briefly discussed. Projects include: cloud water and wet deposition chemistry, hydraulic mounding under community septic systems, estimation of low stream flows on ungaged watersheds, geothermal potential of northern New Hampshire granites, and evaluation of the treatment potential of soils to ash landfill leachate. (USGS)
W90-06243

FISCAL YEAR 1988 PROGRAM REPORT (PUERTO RICO WATER RESOURCES RESEARCH INSTITUTE).
Puerto Rico Univ., Mayaguez. Water Resources Research Inst.

R. Munoz.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-145228/AS. Price codes: A03 in paper copy, A01 in microfche. Report G-1611-01, August 1989. 23p. USGS Contract 14-08-0001-G1611. USGS Project no. G-1611-01.

Descriptors: *Information transfer, *Puerto Rico, *Research, *Training, *Water resources Institutes, Education, Projects.

Four major projects were accepted for research and were sponsored with the 1988 Institute's grant. A study was successfully conducted which reflects the effects of sewage sludge on nutrient and toxic metal content of tropical soils and selected crops grown on them. It was found that fruit and grain quality are generally unaffected by the sludge treatment of the soil and that the intake concentrations of various elements were in the normal safe range. The second project, a study of the sludge composting process using recycled compost as the bulking material, demonstrated that recycled compost used as bulking material produces yields comparable to those obtained by using fresh bulking material. The fourth project, related to hydrocarbon content of groundwater near gasoline stations, required drilling sampling holes for the collection of samples. Six observation wells were installed and developed at two sampling sites with underground gasoline storage tanks, boring logs were prepared, and samples were taken for chromatographic analysis. A one-day water resources conference was held in the Mayaguez Campus related to water quality and management in Puerto Rico. A directory of professionals working in the different areas of the broad water resources field was prepared. A total of 8 students (5 undergraduates and 3 graduates) participated in conducting the various research projects developed during the year. (USGS)
W90-06252

FISCAL YEAR 1988 PROGRAM REPORT (RHODE ISLAND WATER RESOURCES CENTER).
Rhode Island Univ., Kingston. Water Resources Center.
C. P. C. Poon.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-145715/AS. Price codes: A04 in paper copy, A01 in microfiche. FY-1988 Institute Program Report, Report No. G-1612-01, July 1989. 54p. Contract 14-08-0001-G1612. USGS Project G1612-01.

Descriptors: *Information transfer, *Research, *Rhode Island, *Training, *Water resources Institutes, Education, Projects.

The State of Rhode Island is active in water resources planning, development, and management activities which include legislation, upgrading of wastewater treatment facilities, upgrading and implementing pretreatment programs, protecting watersheds and aquifers throughout the state. Current and anticipated state water problems are contamination and cleanup of aquifers to protect the valuable groundwater resources; protection of watersheds by controlling nonpoint source pollution; development of pretreatment technologies; and deteriorating groundwater quality from landfill leachate or drainage from septic tank leaching field. Seven projects were included covering the following subjects: (1) Radon and its nuclei parents in bedrock; (2) Model for natural flushing of aquifer; (3) Microbial treatment of heavy metals; (4) Vegetative uptake of nitrate; (5) Microbial processes in vegetative buffer strips; (6) Leachate characterization in landfills; and (7) Electrochemical treatment of heavy metals and cyanide. This Center works closely with the R.I. Dept. of Environmental Management; R.I. Solid Waste Management Corp., USGS Subdistrict Office, USEPA region 1 Office, Other New England Water Resources Centers, and citizen groups in program planning as well as in research coordination. (USGS)
W90-06254

FISCAL YEAR 1988 PROGRAM REPORT (NEW MEXICO WATER RESOURCES RESEARCH INSTITUTE).
New Mexico Water Resources Research Inst., Las Cruces.
T. G. Bahr.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-132655/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G1578-01, July 1989. 37p. USGS contract 14-08-0001-G1578. USGS project G1578-01.

Descriptors: *Information transfer, *New Mexico, *Research, *Training, *Water resources Institutes, Education, Projects.

The New Mexico Water Resources Research Institute's (WRRI) goal is to maintain a balanced research program that addresses water problems critical to New Mexico, the Southwest and the nation. Areas targeted as high priority for institute funding are: (1) water conservation, primarily toward development of water conserving agricultural crops; (2) development of economically beneficial uses for impaired quality water; (3) surface/groundwater relationships, particularly recharge; and (4) water quality, focusing on protecting present and anticipated water uses from impairment by actions that affect the quality of the water. The institute's USGS program supported three projects in the first area: a project that employed advanced genetic engineering research to identify new gene sources that can be used to develop stress-tolerant plants, a second project which studied the correlation between the genetic differences observed in heat resistant and heat sensitive lines of cotton and heat shock protein expression, and a third project which investigated the existing constraints on irrigators' ability to realize the value of conserved irrigation water. Area two was addressed by a project which investigated the economic potential for growing algae for oil (lipid) production. The third priority area was addressed by two projects. One project analyzed clay minerals for their composition, their proportions in the rock matrix and their effects on porosity and transmissivity. The other project evaluated whether three dimensional flow of soil moisture plays a significant role in calculating recharge or evapotranspiration on a local scale. The final priority category was addressed by three projects. The first studied the nature of multiphase flow in a near-surface environment with an emphasis on capillary trapped liquid organics which replenish the air and water with dangerous and/or toxic material. The second studied solute dispersion, or the tendency of pollution to spread out as it travels along with the water. The third continued the development of effective and reliable tools for speciation analysis of natural waters, which will provide a better understanding of the toxicity, bioavailability and transport of trace metals. (USGS)
W90-06260

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

BIBLIOGRAPHY OF FISHERY INVESTIGATIONS ON LARGE SALMONID RIVER SYSTEMS WITH SPECIAL EMPHASIS ON THE BOIS BRULE RIVER, DOUGLAS COUNTY, WISCONSIN.
Wisconsin Dept. of Natural Resources, Madison.
R. B. DuBois.
Technical Bulletin No. 166, 1989. 58p, 966 ref.

Descriptors: *Bibliographies, *Fisheries, *Salmon, *Trout, *Wisconsin, *Bois Brule River.

This report provides 966 literature citations pertinent to management of salmonids in lotic systems. Of these citations, 229 (24%) include brief annotations to highlight their salient aspects to management of the Bois Brule River and other northern Wisconsin trout rivers. The subject index lists citations under 41 topic headings in 5 categories: Biology (10 headings), Ecology (9 headings), Management (13 headings), Sport Fishery Assessment (4 headings), and Physical Environment (5 headings). A salmonid species index is also provided. (Author's abstract)
W90-05735

WATER-RELATED SCIENTIFIC ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN NEVADA, FISCAL YEARS 1985-89.
Geological Survey, Carson City, NV. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-06226

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1 NATURE OF WATER

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5 WATER QUALITY MANAGEMENT AND PROTECTION

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